2015 Montana State University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

The Montana State University (MSU) College of Agriculture (COA), Montana Agricultural Experiment Station (MAES) and Montana State University Extension (Extension) are pleased to present this 2015 Annual Report of Accomplishments and Results. The report not only highlights annual accomplishments, it also represents the breadth and depth of MSU Extension and COA/MAES leadership and productivity in many aspects of twenty-first century science, outreach, education and innovation.

ORGANIZATION

Montana is home to eight land-grant institutions, the most of any state in the nation. Of the eight, only Montana State University, which includes MAES through the Hatch Act and Extension through the Smith- Lever Act, is part of the original Morrill Act of 1862. The other seven are tribal colleges that received land-grant designation through the Elementary and Secondary Education Reauthorization Act of 1994. These institutions and their tribal affiliations are; Anaiih Nakoda College (Gros Ventre and Assiniboine), Blackfeet Community College (Blackfeet), Chief Dull Knife College (Northern Cheyenne), Fort Peck Community College (Sioux and Assiniboine), Little Big Horn College (Crow), Salish Kootenai College (Bitterroot Salish and Pend d'Oreilles) and Stone Child College (Chippewa-Cree). Having eight land-grants is a growing source of pride for Montana as there are increasing numbers of partnerships that create comprehensive connections among them and elevate all citizens through the tripartite mission of research, education and outreach.

The 1994 tribal colleges serve primarily American Indian populations located in remote, under-served communities that otherwise lack access to higher education. They are critically important to the people they serve and include culturally relevant curriculum and programs that enhance cultural and historical identity. In addition to adopting the land-grant mission in 1994, five of the reservations also partner with MSU Extension through the Federally Recognized Tribes Extension Program (FRTEP). The Blackfeet, Flathead, Fort Belknap, Fort Peck and Northern Cheyenne reservations all have Extension agents who live and work in the community and perform duties much like county agents. FRTEP accomplishments are included within this report.

UNDERSERVED AND UNDERREPRESENTED POPULATIONS

The COA, MAES and Extension cooperatively design and implement programs that best align with Montana's sovereign Indian Nations. Because this demographic (6.6% of Montana's population (US Census Bureau. American Community Survey (ACS) 2014)) is largely underserved and underrepresented, programs and goals were targeted to generate strong and beneficial interactions regarding respective Montana reservation struggles, priorities and needs. COA, MAES and Extension worked closely with tribal councils and colleges across the Rocky Mountain region, and agents and educators provided a variety of academic programs and opportunities in areas including livestock management, childhood obesity, food preservation and safety, pasture restoration, environmental stewardship, community development, youth development, sustainable agricultural practices, resource and risk management, pesticide certification and

more.

Montana is also home to about 50 Hutterite colonies (population approximately 5200) and a small number of African Americans (.5%), Asians (.5%) and Hispanic/Latino (4.8%) citizens. Recent growth and recession in mining communities has increased the number of transient and migratory workers in some areas. Cultural sensitivity and inclusiveness remained an institutional priority for all COA, MAES and Extension programming.

In 2014 Montana's median household income ranked 38th in the nation (US Census Bureau. American Community Survey (ACS) 2014). The 2013 ACS found that 21.3% of Montana's children and 16.5% of all people lived below the poverty rate. Nearly 12% of families were food insecure and almost 5% very low food insecure. Food deserts exist across vast parts of Montana adding to the challenge of accessing nutritious foods.

Food insecure and low-income people are especially vulnerable to obesity and other health-related problems due to additional risk factors associated with poverty. Extension was active in meeting the needs of these underserved people through targeted programming. Extension also worked with both growing and shrinking communities to help them develop sustainable tools including setting up or growing community foundations and providing leadership training.

COA and MAES

COA and MAES 2015 accomplishments and results represent modern day achievements in 151 years of honoring the legacy and commitment within the land-grant tradition. Federal Hatch Act funding continues to allow MSU's faculty scientists to meet the changing needs of Montana, explore unique solutions to pressing questions, and solve global problems in agriculture. HATCH funding continues as the critical foundation for COA and MAES scientists to be successful in competition for complimentary national-level grant funding. The college consistently ranks in the top tier of the university's annual research expenditures and has seen an increase in research activity.

EXTENSION
Smith-Lever funds contribute to the ability of MSU Extension to improve the lives and livelihood of Montana citizens by quickly responding to local needs and challenges, seeking and conducting appropriate research and discovery through the university and sharing new knowledge in local communities. Extension's 92 agents and 34 specialists live and work in more than 60 communities statewide. Their presence allows them to understand local challenges and successes in four broad areas: community development, family and consumer sciences, youth development and agriculture and natural resources. Extension fulfills the Smith-Lever mission by bridging the university, including the COA and MAES, to the people.

REPORT ORGANIZATION

In 2014, the COA/MAES and Extension completed a significant overhaul with a combined Federal Plan of Work which included input and suggestions from many within all three organizations. In order to ease the transition for faculty and staff, this 2015 report includes the newly named program areas which are defined in the 2016-2021 Plan of Work. These eight programs effectively incorporate the body and breadth of work being accomplished by COA, MAES and Extension.

1. ANIMAL SCIENCES (renamed from Livestock): animal health, marketability, sustainability and profitability related to beef, sheep, swine, poultry, goats and equine.
2. PLANT AND SOIL SCIENCES (renamed from Field Crops and Rangelands): productivity, genomics,

pathology, impacts of climate change, adaptability, cropping systems, pests and diseases and horticulture
3. FARM AND RANCH AND BUSINESS MANAGEMENT (renamed from Farm and Ranch Management): best practices, contracts, estate planning, marketing, taxation, operational planning, budgeting, agricultural policy, commodity support programs, risk management and decision support software.
4. ENERGY AND NATURAL RESOURCES: Forest stewardship, water quality, range management, wildlife, fossil fuels, alternative energy, recreational land use and tourism and cultural resources.
5. PEST AND DISEASE MANAGEMENT (added): food safety, quality, cost, biodiversity, sustainability, weed control, pests, diseases, biological control, agricultural practices and environmental policies.
6. HEALTHY LIVING, FOOD and NUTRITION: chronic diseases, disability, healthy food choices, physical activity, independence, quality of life.
7. YOUTH AND FAMILY DEVELOPMENT (renamed from Youth and Adult Development): youth development, leadership, citizenship, personal finances, caregiving, resource management, aging, estate distribution.
8. COMMUNITY DEVELOPMENT: local governance, strategic planning, leadership development, public officials training, citizen board workshops, community foundation education, conflict management, community health and grant-writing

In addition, we moved the programs titled HORTICULTURE (outputs and outcomes are included under Plant and Soil Sciences); and HOUSING AND BUILT ENVIRONMENTS (outputs and outcomes are included under Health Living, Community Development, or Energy and Natural Resources).

As the goals and outcomes throughout this report attest, the challenges and opportunities in Montana are endless. Increasingly, Extension, COA and MAES serve a growing, diverse constituency with limited resources. Extension, COA and MAES consistently utilize methods that are timely, relevant and cost effective, demonstrating excellent stewardship.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	31.0	{No Data Entered}	268.0	{No Data Entered}
Actual	43.7	0.0	339.0	0.0

II. Merit Review Process

1. The Merit Review Process that was Employed for this year

- ☑ Internal University Panel
- ☑ External University Panel
- ☑ External Non-University Panel
- ☑ Combined External and Internal University Panel
- ☑ Combined External and Internal University External Non-University Panel
- ☑ Expert Peer Review
- ☑ Other (Dept. Head External to PI's Dept.)

2. Brief Explanation

Department heads with the MAES and COA review Hatch Projects at the department level. A committee of peers then reviews the project and passes it to the director for final approval. The MAES director's office ensures this process is done as efficiently as possible. The peer review committee, selected by the director after consultation with COA department heads, includes the principle investigator's (PI) department head, MAES administrator, one department peer reviewer and two additional faculty external to the PI's department. Researchers present seminars to the review committee and interested stakeholders, including faculty, staff, students, and constituents. The director requires researchers to propose new projects for a three year period, while researchers with favorably reviewed ongoing projects continue for five years. External expert reviews occur with Montana State University faculty external to the COA, as a requirement of the review process. Presenters announce all seminars ensuring broader attendance and input potential. Reviewers provide written recommendations on the following: relevance and importance of the project; relationship of the project to previous research; objectives; approach and methods; scientific and technical quality; resources; environmental, economic, and/or social impacts. The MAES administrator and department head share the responses with the PI. If the projects do not meet expectations the director will not approve them and will defer them until the researcher meets the key elements satisfactorily. Ultimately, the office staff submits the director-approved projects to USDA-NIFA for final approval.

MSU Extension uses a Merit Review Process for the Annual Report. Individual program leaders, agents and specialists are involved in the creation of the report at each step. Internal editors carefully read each section for content, grammar and overall quality review. In addition, an external Merit Review Panel consisting of passionate supporters with tremendous historical knowledge of MSU Extension and Montana carefully reviews the documents, providing important, expanded perspectives and input. The Merit Review Panel includes: Jim DeBree (33 years with MSU and Wyoming Extension, retired as Director of Wyoming Extension), Dr. James Hafer (chair and instructor of the Agricultural and Natural Resource Sciences program at Chief Dull Knife College) and Charles Rust (retired agricultural economist and interim Director of MSU Extension). This group was selected due to their experience related to Extension, outreach education and Montana culture.

III. Stakeholder Input

1. Actions taken to seek stakeholder input that encouraged their participation

- ☑ Use of media to announce public meetings and listening sessions
- ☑ Targeted invitation to traditional stakeholder groups
- ☑ Targeted invitation to non-traditional stakeholder groups
- ☑ Targeted invitation to traditional stakeholder individuals
- ☑ Targeted invitation to non-traditional stakeholder individuals
- ☑ Targeted invitation to selected individuals from general public
- ☑ Survey of traditional stakeholder groups
- ☑ Survey of traditional stakeholder individuals
- ☑ Survey of the general public
- ☑ Survey specifically with non-traditional groups
- ☑ Survey specifically with non-traditional individuals
- ☑ Survey of selected individuals from the general public

☑ Other (Educational outreach programs)

Brief explanation.

Personal contact is one of the most successful ways for Extension to gain stakeholder participation. Clientele regularly provide input about which issues are important to them, their families and communities. In addition, Extension professionals reach out to others by staying in regular contact with commodity associations, various government agencies and other partners to assure they are aware of and understand the most current needs and concerns of clients.

Extension agents are located within Montana communities and are an active part of the day-to-day functions of towns, cities, counties and reservations. Agents are often members of community foundations and boards (such as county or tribal weed boards, chamber boards, school boards) and use the knowledge and information they gain in this capacity, as well as face-to-face meetings, to prioritize and strategize the best use of their time, dollars and other resources.

Many specialists spend an abundant portion of their time in fields, gardens, feedlots and town halls with the people they serve. They know that they must have a close relationship with key stakeholders to receive honest feedback and be considered as a valuable resource.

Radio, newsletters, newspapers, social media and electronic distribution lists are also used to inform clientele about the opportunity to make requests for Extension assistance. Informational booths are set up at agricultural trade shows, home and garden shows and health fairs, allowing for discussions with people who are not regular clientele of Extension. This kind of conversation reveals concerns and issues that might not be heard in the usual process. When common issues surface through these methods and the advisory process, they will be incorporated into Extension planning.

MAES and COA obtain stakeholder input on research priorities and programs through a small, yet well-connected group that represent the myriad interests in Montana agriculture. Stakeholder committees include the sustainable agriculture focus group, MAES State Advisory Council, Ag Coalition and other state and local groups. Agriculture interest groups consist of representation from the Agricultural Business Association, Farm Bureau Federation, Montana Stockgrowers, Montana Farmers Union, Montana Water Users, Montana Wool Growers, Seed Growers, and the Seed Trade. It meets periodically with the dean and director to review program priorities, new initiatives, fundraising efforts, and legislative activities.

The College advertises the meetings via news releases, newsletters, individual letters, and announcements at group meetings. The MAES responds to stakeholder inputs by considering their proposals at research planning meetings with scientists, advisory groups, and administrators. Administrators solicit stakeholder input at the strategic planning process and as programs are developed, implemented, and sometimes redesigned. Local advisory committees to the research centers also provide annual and long-term guidance to the College and MAES. MAES scientists routinely participate with these groups and NRCS to provide training and expertise in many of scientific and program areas.

2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- ☑ Use Advisory Committees
- ☑ Use Internal Focus Groups
- ☑ Use External Focus Groups
- ☑ Open Listening Sessions
- ☑ Needs Assessments
- ☑ Use Surveys
- ☐ Other

Brief explanation.

The seven agricultural research centers have local advisory groups that meet multiple times through the year. In addition, a State Advisory Council meets three times each year to discuss program focus and direction, Montana legislative priorities, and productivity/impact. These meetings are open to the public. Administrators and faculty in COA/MAES serve on agricultural association committees that annually direct and fund research activities. These committees use a variety of collection methods, but the most common are face-to-face meetings, telephone, and some video conferencing.

The Montana Extension Advisory Council (MEAC) is a statewide group that meets at least twice per year to discuss the overall direction and priorities for MSU Extension. Membership on MEAC is based on geographic representation, areas of interest, a tribal representative and an elected 4-H ambassador, and previous relationship with Extension. Recruitment from specific sectors such as healthcare, government agencies and community development are also targeted. County agents and state specialists, Extension program leaders and regional department heads are asked to make recommendations for membership to MEAC. Those who are elected serve a three year term.

Many counties also have local advisory groups. Membership on these boards is achieved by sending an invitation to traditional stakeholder groups requesting the name of an individual who can represent views and provide input for Extension programming. A similar invitation is sent to nontraditional groups. In cases where a group may not be familiar with Extension, personal contact is made to explain the role of the representative.

During programs targeted at certain audiences (Expanded Food and Nutrition Education Programs (EFNEP), Supplemental Nutrition Assistance Program-Education (SNAP-Ed), attendees are asked directly for input or may be asked to serve on a specific advisory committee for the program area.

Occasionally, broad surveys or requests for information are made. For instance, in 2014 Flathead County did an extensive county-wide review of their programming that resulted in a full report which will guide their activities going forward.

2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- ☑ Meeting with traditional Stakeholder groups
- ☑ Survey of traditional Stakeholder groups
- ☑ Meeting with traditional Stakeholder individuals
- ☑ Survey of traditional Stakeholder individuals
- ☐ Meeting with the general public (open meeting advertised to all)
- ☑ Survey of the general public
- ☑ Meeting specifically with non-traditional groups
- ☑ Survey specifically with non-traditional groups
- ☐ Meeting specifically with non-traditional individuals
- ☐ Survey specifically with non-traditional individuals
- ☐ Meeting with invited selected individuals from the general public
- ☑ Survey of selected individuals from the general public
- ☐ Other

Brief explanation.

The most common method of gathering stakeholder input is from interaction with regular clientele of MSU Extension. Often this occurs in intentional program planning sessions to which these people are invited, requested to attend or are required to be present by their role or position. Examples of groups that may fall into this category are county/reservation 4-H Councils, livestock associations, weed boards, human resource coalitions, local and state agricultural organizations, Ag Research Center Advisory Committees and special interest groups. Some of these groups have offices or directing boards that are asked for specific input.

County and state advisory committees are also used to gather input. Advisory groups are generally comprised of a cross section of leadership and citizens in the county. Efforts are made to involve the underserved and underrepresented clientele by contacting agencies and organizations that regularly work with a particular audience. They are asked for input and/or for names of people who could provide input directly. Local Extension agents follow up with personal conversations to explain the goals and process.

At the state level, one of the most valuable sources of input is from the Montana Association of Counties (MACo). Extension makes presentations during MACo's Annual Meeting, followed by an open session for mutual dialogue. These types of discussions also happen during the newly elected county commissioners' orientation and have proven very beneficial. Extension administration, through regional department heads (RDHs), also gather stakeholder information from county commissioners.

Through direct participation with agricultural stakeholder groups, broad participation in committees, and directed meetings, MAES listens to and considers defined problems or questions that research programs can address. COA/MAES considers the voice of public stakeholders at every turn and works closely alongside various producer groups to critique and share applied research and methodology. It is common for many of Montana's public and private agricultural groups to hold meetings in COA/MAES facilities on campus, or for state-wide producers to volunteer a portion of

their acreage for research studies. The director targets selective meetings with nontraditional groups. Montana has an open meeting law. Therefore, all meetings are open to the public and the organizer must publish an agenda.

3. A statement of how the input will be considered

- ☑ In the Budget Process
- ☑ To Identify Emerging Issues
- ☑ Redirect Extension Programs
- ☑ Redirect Research Programs
- ☑ In the Staff Hiring Process
- ☑ In the Action Plans
- ☑ To Set Priorities
- ☑ Other (Create a basis for additional resources)

Brief explanation.

As a Land Grant Institution Montana State University has a solid foundation of past and future program activities that allow stakeholder input and strong interactive dialogue, and the COA, MAES and Extension clearly set the tone for this interactive environment. The College, research centers and Extension serve as the primary conduit for connection and delivery of education and new knowledge in activities throughout rural Montana.

Advancements in the Animal and Range Sciences Department provide an example of how stakeholder input resulted in specific actions. Stakeholder requests for a more comprehensive beef, cattle, and genomics program resulted in:

• A new Animal Bioscience Building built in 2010

• Three new full-time faculty positions in Animal and Range Sciences and a second Extension Beef Cattle Specialist

• New equipment, including a: Torrent Personal Genome Machine for profiling genetic information taken from livestock samples

• Illimina MiSeq which collects specific information from multiple DNA molecules helping scientists study microbial life in a sample

• Maxwell 16 (a machine which extracts nucleic acid and runs 16 DNA samples at a time)

• Polymerase chain reaction machine

• Refrigerated micro centrifuge

• Computer bio-analyzer which measures RNA and DNA samples

• Necropsy down-draft tables for laboratories complete with ceiling cameras

• The creation of two endowed chairs for the university; one in Animal and Range Sciences and another in Plant Sciences and Plant Pathology.

Brief Explanation of what you learned from your Stakeholders

Stakeholders play a key role in our programs, and they are pleased with the direction the College of Agriculture, the Montana Agricultural Experiment Station and Extension are going. During recent legislative hearings key stakeholders repeatedly testified about COA, MAES and Extension accomplishments from integrated pest management and wheat breeding programs, to the excitement generated with the application of latest molecular technologies towards agricultural and natural resource systems.

It is also worth noting that, in recognition of the value MSU places on its relationship with the agricultural community and its stake in the agricultural industry, MSU named the COA/MAES current dean and director as a Vice President of the university. This is the first time Agriculture has had a vice presidency at MSU, currently occupied by Dr. Charles Boyer.

In addition to agriculture, Extension addresses concerns of Montana stakeholders in a wide range of issues similar to those receiving attention across the nation. Many Montanans worry about job security and accessing health care in their rural community. Rural families wonder if local schools will remain open, or conversely if overcrowding and transiency will continue to cause issues. In those areas where education can help address the issue, Montanans look to Extension as an unbiased resource that can help them make choices and decisions that are best for their families, businesses and communities.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
2727503	0	2772884	0

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	1152738	0	3085893	0
Actual Matching	0	0	13892014	0
Actual All Other	1132463	0	13752777	0
Total Actual Expended	2285201	0	30730684	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	2470506	0

V. Planned Program Table of Content

S. No.	PROGRAM NAME
1	Animal Sciences
2	Plant and Soil Sciences
3	Farm and Ranch and Business Management
4	Integrated Pest Management
5	Energy and Natural Resources
6	Youth and Family Development
7	Healthy Living, Nutrition and Food Safety
8	Community Development
9	Housing and Built Environments
10	Horticulture

Add previously unplanned program

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Animal Sciences

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
121	Management of Range Resources	10%		5%	
301	Reproductive Performance of Animals	5%		5%	
302	Nutrient Utilization in Animals	5%		5%	
303	Genetic Improvement of Animals	0%		5%	
305	Animal Physiological Processes	0%		5%	
306	Environmental Stress in Animals	5%		5%	
307	Animal Management Systems	5%		5%	
308	Improved Animal Products (Before Harvest)	5%		5%	
311	Animal Diseases	10%		5%	
312	External Parasites and Pests of Animals	0%		5%	
315	Animal Welfare/Well-Being and Protection	10%		5%	
503	Quality Maintenance in Storing and Marketing Food Products	0%		5%	
511	New and Improved Non-Food Products and Processes	0%		5%	
603	Market Economics	5%		5%	
604	Marketing and Distribution Practices	5%		5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	0%		5%	
722	Zoonotic Diseases and Parasites Affecting Humans	0%		5%	
901	Program and Project Design, and Statistics	0%		5%	
902	Administration of Projects and Programs	0%		5%	
903	Communication, Education, and Information Delivery	35%		5%	
	Total	100%		100%	

Add knowledge area

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	3.0	0.0	71.6	0.0
Actual Paid	4.5	0.0	78.9	0.0
Actual Volunteer	0.5	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
128765	0	631807	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	3364755	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
80704	0	4843856	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Met one-on-one with producers, landowners and consumers to identify and address individual problems and solutions
- Encouraged email and phone conversations with members of the public
- Offered classes, workshops, group discussions, demonstrations, field tours/trials, webinars
- Shared information at farmer's markets, county fairs and other community events
- Attended and presented information at professional conferences, county meetings and state conventions
- Prepared and distributed knowledge through public service announcements, newsletters, MONTGuides, Television (Montana PBS Montana Ag Live), eXtension, listservs, blogs, radio and other media
- Created readily available and easily accessible databases for producers and researchers
- Prepared research articles, fact sheets and news releases for scientists and statewide media
- Hosted strategic planning meetings with state agricultural groups
- Developed systems that ensure food safety and agricultural security
- Integrated best practices for beef quality assurance in programs

2. Brief description of the target audience

- Livestock producers
- Commodity Associations
- Land managers/owners (small and large)

- Weed Control Professionals
- State Agencies
- County Weed Boards
- Colleagues and related stakeholders
- Animal health businesses
- Legislators, county commissioners and other elected officials
- Rodeo team and related partners
- Tribal land managers, producers and leadership
- Native American youth
- Farm and ranch families
- Beginning farmer and ranchers
- Allied industry stakeholders

3. How was eXtension used?

Agents and specialists utilized eXtension to provide webinars and programming, share fact sheets, evaluate courses and programs (Moodle), conduct radio interviews, create Extension documents and as a general resource. The Livestock and Poultry Learning Center Community of Practice (COP) was a major collaborator/partner in state and national outreach on issues including the Avian Bird Flu epidemic in America in 2015.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	8061	92358	1869	10000

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	18	57	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research citations

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	75

Output #2

Output Measure

- Number of publications on infectious disease and vaccines research

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	25

Output #3

Output Measure

- Number of presentations on infectious disease research

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	150

Output #4

Output Measure

- Number of undergraduate and graduate students trained in animal science and biotechnology

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	100

Output #5

Output Measure

- Number of producers attending meetings/workshops and clinics

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	9930

Output #6

Output Measure

- Number of producers utilizing ration-balancing

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #7

Output Measure

- Number of Native American Youth completing quality assurance training and receiving Junior Ag Loans

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	28

Output #8

Output Measure

- Number of outreach, training and education events

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	44

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Extension and MAES Beef Cattle Programs -Increase the number of producers using Extension and MAES information to successfully manage animal health and well-being issues. -Increase the number of producers who successfully utilize Extension and MAES programs to improve profitability. -Increase the number of producers who successfully utilize Extension and MAES to improve environmentally sustainable practices.
2	Extension and MAES Sheep Programs -Improve profitability of producers in the sheep and wool market through increased participation in and knowledge gained from seminars, classes and other educational opportunities; and expanding wool pools, wool delivery and marketing.
3	Identification of critical infection and disease resistance
4	Number of improvements to vaccines developed
5	Identification of genetic correlations and other factors influencing residual feed intake and feed efficiency; and education of producers and industry leaders with latest the scientific information
6	Conduct basic and applied infectious disease research -Increase the quality of meat, milk and fiber products -Reduce non-predator deaths in calves
7	Extension Beef Cattle Programs -Increase the number of producers who use Extension resources to successfully manage animal health and well-being issues and improve profitability and environmentally sustainable practices.

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Extension and MAES Beef Cattle Programs -Increase the number of producers using Extension and MAES information to successfully manage animal health and well-being issues. -Increase the number of producers who successfully utilize Extension and MAES programs to improve profitability. -Increase the number of producers who successfully utilize Extension and MAES to improve environmentally sustainable practices.

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◉ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Beef cattle production results in the greatest share of agriculture receipts in Montana.The 2014 State Agriculture Overview report by the USDA indicates that Montana?s cattle and calves industry brought in $1.8 billion and cow milk another $44 million. There were 2.63 million cattle and calves in inventory. Volatile cattle and feed markets, as well as rising input costs, provide challenges to sustainable production.

What has been done
General research within animal nutrition, health, and reproductive performance made great strides in exploratory research in animal and range sciences. Publications, meetings, conferences and materials were disseminated statewide to producers and stakeholders, in addition to research advancements in: the role of microbiota in health and reproductive performance, nutritional management of range cows, meat quality, zoonotic diseases and animal genetic improvement.

Results
Health and reproductive success of livestock animals overlaps and collectively underpins the economic performance of all livestock operations. Together, MAES and Extension serve as the research and outreach center for state livestock producers. Again in 2015, both agencies supported livestock consumers and producers by producing non-biased, scientific-based research on general animal health through meetings, conferences, research discoveries, coursework, the training of graduate students, research citations, and stakeholder association meetings.

Extension agents disseminated timely and applicable research to the state's livestock community.

4. Associated Knowledge Areas

- ☑ 121 - Management of Range Resources
- ☑ 301 - Reproductive Performance of Animals
- ☑ 302 - Nutrient Utilization in Animals
- ☑ 303 - Genetic Improvement of Animals
- ☑ 305 - Animal Physiological Processes
- ☑ 306 - Environmental Stress in Animals
- ☑ 307 - Animal Management Systems
- ☑ 308 - Improved Animal Products (Before Harvest)
- ☑ 311 - Animal Diseases
- ☑ 312 - External Parasites and Pests of Animals
- ☑ 315 - Animal Welfare/Well-Being and Protection
- ☐ 503 - Quality Maintenance in Storing and Marketing Food Products
- ☐ 511 - New and Improved Non-Food Products and Processes
- ☑ 603 - Market Economics
- ☐ 604 - Marketing and Distribution Practices
- ☑ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☑ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☐ 901 - Program and Project Design, and Statistics
- ☐ 902 - Administration of Projects and Programs
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Extension and MAES Sheep Programs -Improve profitability of producers in the sheep and wool market through increased participation in and knowledge gained from seminars, classes and other educational opportunities; and expanding wool pools, wool delivery and marketing.

2. Associated Institution Types

- ☑ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	184

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Montana State University has been directly tied with the sheep industry since its founding in 1893. Extension, COA and MAES have been deeply involved in generations long breeding programs, expansive grazing and weed control initiatives and concentrated, strategic efforts to make Montana wool more competitive in the world market. Impactful engagement at all levels has enhanced the industry which supports 230,000 plus sheep, earning Montana a ranking of 10th in value of sales nationwide at over $31.2M annually. Current research seeks to identify genetic and genomic tools that eliminate the need to measure large numbers of animals for various traits, instead allowing for a streamlined approach to predicting performance.

What has been done

A long-term breeding program involving Rambouillet sheep selected from genetically distinct populations was created. The hope is to find distinct genetic markers, gene expression patterns and altered physiology that can provide candidate gene markers for the reproductive efficiency in other sheep and other livestock species.
A new Extension sheep specialist began in 2015 following the 33 year career of his predecessor. This specialist conducted needs assessments with a range of clientele that will allow him to develop meaningful programming for the future. Extension hosted six seminars (184 producers) on nutrition, animal health, grazing and improving profitability.

Results

A follow-up study has been completed evaluating the potential anabolic activities of progesterone that may relate to differences in high and low reproductive rates. This is currently under analysis. Another study has been completed to evaluate individual animal variation in extreme high and low RFT growing lambs, which were identified after a 42 day field trial. After slaughter organ weights, body composition and gene expression and carcass characteristics were reported. Results were presented at the World Congress of Genetics Applied to Livestock Production and at the National Animal Science Meeting.

The Montana Wool Growers Young Producers Forum was formed to guide strategic programming that directly addresses the challenges of the next generation of sheep producers. Producers who attended seminars indicated they better understood regional and national issues facing the industry and would utilize information on grazing hay aftermath and nutrition.

4. Associated Knowledge Areas

- ☑ 121 - Management of Range Resources
- ☑ 301 - Reproductive Performance of Animals
- ☑ 302 - Nutrient Utilization in Animals
- ☑ 303 - Genetic Improvement of Animals
- ☑ 305 - Animal Physiological Processes

- ☐ 306 - Environmental Stress in Animals
- ☑ 307 - Animal Management Systems
- ☐ 308 - Improved Animal Products (Before Harvest)
- ☐ 311 - Animal Diseases
- ☐ 312 - External Parasites and Pests of Animals
- ☑ 315 - Animal Welfare/Well-Being and Protection
- ☐ 503 - Quality Maintenance in Storing and Marketing Food Products
- ☑ 511 - New and Improved Non-Food Products and Processes
- ☑ 603 - Market Economics
- ☑ 604 - Marketing and Distribution Practices
- ☐ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☐ 901 - Program and Project Design, and Statistics
- ☐ 902 - Administration of Projects and Programs
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Identification of critical infection and disease resistance

2. Associated Institution Types

- ☑ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There are a range of infectious diseases that drastically affect the livestock industry in Montana. Intestinal and respiratory diseases still cause considerable losses to the livestock industry. Use of antibiotics to treat many of these diseases are becoming more problematic because of the

development of resistance and increasing public concern regarding their use. Effective vaccines are also lacking for many of the disease agents. New approaches are needed to counter these infectious diseases.

What has been done
Gamma/delta T cells comprise a large percentage of circulating lymphocytes in bovine blood and are also found in large numbers within epithelial tissues, particularly the intestinal mucosa, and traffic to infection sites, underscoring their likely role in innate production. Acai PS was tested as a safe, effective approach to enhance bovine calf resistance to bacterial challenge.
Extension joined with Washington State University to survey Montana beef cattle producers and veterinarians about a unique form of neonatal calf pneumonia that has been diagnosed in several Montana herds over the last 8 years. Data from the survey will be used to study cause as well as to develop treatment and/or management strategies to prevent calf loss.

Results
The majority of experiments were initiated this year and results were published in several peer reviewed journals and were presented at a scientific conference focused on vaccines in livestock. Researchers are currently testing if pre-treatment of calves with Acai PS will reduce disease and bacterial shedding following oral Salmonella infection. Additionally, researchers determined the composition of cattle and sheep vaginal microbiota co-varies with reproductive performance, routes of transmission of early colonizing microbioata in livestock were found, microbes were identified that correlate with indicators of reproductive performance, neonatal health and animal performance in livestock.

4. Associated Knowledge Areas

- ☐ 121 - Management of Range Resources
- ☑ 301 - Reproductive Performance of Animals
- ☐ 302 - Nutrient Utilization in Animals
- ☑ 303 - Genetic Improvement of Animals
- ☐ 305 - Animal Physiological Processes
- ☐ 306 - Environmental Stress in Animals
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- ☐ 603 - Market Economics
- ☐ 604 - Marketing and Distribution Practices
- ☐ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☐ 901 - Program and Project Design, and Statistics
- ☐ 902 - Administration of Projects and Programs

☐ 903 - Communication, Education, and Information Delivery

Outcome #4

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Number of improvements to vaccines developed

2. Associated Institution Types

☐ 1862 Extension

☑ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure

◯ Change in Action Outcome Measure

◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There are a range of infectious diseases that drastically affect the livestock industry in Montana. In many common subclinical or chronic cases, several diseases can persist for months with little physical or behavioral identification from the animal. In research areas such as mastitis in cattle, salmonellosis in calves, and several emerging arthropod-vectored diseases in livestock and cattle, improvements to vaccines and treatments are critical.

What has been done

Researchers investigated and analyzed the role of bovine gamma/delta T cells by focusing on studies of unique gene expression as well as development approaches to control their activity to the ultimate benefit of the animal. Initial in-vitro studies were done on the effects of AcaiPS on bovine immune cells and in-vitro studies on the effects of AcaiPS on bovine leukocytes were completed.

Results

The direct impact of this work provides a general understanding of the bovine immune system and how it is similar and dissimilar to the immune system in rodents and humans. This information currently and well into the future, should facilitate development of new approaches to treat infectious diseases in cattle. Several research papers in multiple publications were published in these veins, and researchers found unexpected results that will require further confirmation in experiments in the coming year. Early results and abstracts were submitted at the national AAI meeting and the annual USDA/NIFA Project Directors meeting.

4. Associated Knowledge Areas

- ☐ 121 - Management of Range Resources
- ☐ 301 - Reproductive Performance of Animals
- ☐ 302 - Nutrient Utilization in Animals
- ☐ 303 - Genetic Improvement of Animals
- ☑ 305 - Animal Physiological Processes
- ☐ 306 - Environmental Stress in Animals
- ☑ 307 - Animal Management Systems
- ☐ 308 - Improved Animal Products (Before Harvest)
- ☑ 311 - Animal Diseases
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- ☐ 603 - Market Economics
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- ☐ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☑ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☐ 901 - Program and Project Design, and Statistics
- ☐ 902 - Administration of Projects and Programs
- ☐ 903 - Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Identification of genetic correlations and other factors influencing residual feed intake and feed efficiency; and education of producers and industry leaders with latest the scientific information

2. Associated Institution Types

- ☑ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ○ Change in Action Outcome Measure
- ○ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual

2015 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Beef cattle production on Montana farms and ranches provided $2.2 billion to the state's economy in 2014. These operations rely heavily on forages to supply nutrients for both cows and calves. For much of the cow-calf production cycle, requirements for protein and energy can be met with low to medium quality forages. When forage quantity or quality is limited, feeding supplements may be necessary to maintain the desired level of animal performance. Protein supplementation of low quality forages will generally improve forage intake and animal performance however, individual performance measures are needed to assist in evaluating the effectiveness of supplementation.

What has been done
The interactions between level of supplement consumption, supplement delivery method, and forage intake and utilization by beef cows and calves were evaluated. Feeding strategies were integrated to improve forage intake and utilization by beef cows. The variation of individual animal consumption of supplement was documented and the basic processes of controlling forage intake and utilization by ruminants was manipulated by supplementation.

Results
Through Extension programs and one-on-one visits producers learned to make more informed decisions when purchasing supplemental feed or non-traditional feedstuffs and/or establishing ranch raised forages and concentrates. By balancing rations, adjusting for antagonists and working through alternatives, producers improved animal health and increased profitability. Producers report things like: I saved $45/head and my cows are healthier; I saved 3% on my annual feed bill; I learned I could use potato tailings I had on hand rather purchasing a grain supplement. Participants at one Cattle School (n=48) increased their knowledge on a scale of 1-5 as follows: Forage quality effects on herd management and nutrition from 3.56 to 4.30 and water quality importance from 3.1 to 4.0.

4. Associated Knowledge Areas

- ☑ 121 - Management of Range Resources
- ☐ 301 - Reproductive Performance of Animals
- ☑ 302 - Nutrient Utilization in Animals
- ☑ 303 - Genetic Improvement of Animals
- ☑ 305 - Animal Physiological Processes
- ☑ 306 - Environmental Stress in Animals
- ☑ 307 - Animal Management Systems
- ☑ 308 - Improved Animal Products (Before Harvest)
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- ☐ 604 - Marketing and Distribution Practices
- ☐ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☐ 901 - Program and Project Design, and Statistics
- ☐ 902 - Administration of Projects and Programs
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #6

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Conduct basic and applied infectious disease research -Increase the quality of meat, milk and fiber products -Reduce non-predator deaths in calves

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Conducting basic and applied infectious disease research for Montana's livestock industry is central to the founding mission of MSU COA/MAES and Extension. The scholarly discovery and dissemination of science and technology supporting livestock, rangelands, and other renewable natural resources in economically and ecologically sustainable systems is critical to the health and wealth of Montana's production livestock industry, as new and invasive diseases continue to be discovered each year within animal systems.

What has been done

Within general exploratory research in applied infectious disease research, short and long term objectives lead to scientific accomplishments and program growth through increased grant and contract activity. While this outcome seems general in nature, the scholarly discovery in science and technology supporting livestock, rangeland and other renewable natural resources provide

economic and ecological sustainable systems for the state's producers. This is particularly true in disease research.

Results
Results of basic and applied infectious research in animal sciences and health are wide-ranging. Primary veins of research include; emerging arthropod-vectored diseases of livestock and wildlife, molecular analysis of phagocyte chemotactic receptors in bovine phagocytes, analysis of gamma T and delta cells, exploring the role of microbitoa in animal nutrition, health and reproductive performance, carcass composition and meat quality, nutritional management of range and beef cows and salmonellosis in calves. Investigative research yields a host of discoveries that ultimately influence the partnership between teaching, research and extension program and provides data to peers in the fields of animal and range science, government land agencies, students of agriculture and ecology and associated fields of agriculture and ecology.

4. Associated Knowledge Areas

- ☑ 121 - Management of Range Resources
- ☑ 301 - Reproductive Performance of Animals
- ☑ 302 - Nutrient Utilization in Animals
- ☑ 303 - Genetic Improvement of Animals
- ☑ 305 - Animal Physiological Processes
- ☐ 306 - Environmental Stress in Animals
- ☐ 307 - Animal Management Systems
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- ☑ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☑ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☐ 901 - Program and Project Design, and Statistics
- ☐ 902 - Administration of Projects and Programs
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Extension Beef Cattle Programs -Increase the number of producers who use Extension resources to successfully manage animal health and well-being issues and improve profitability and environmentally sustainable practices.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2223

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Beef cattle production results in the greatest share of agriculture receipts in Montana. The USDA's 2014 State Agriculture Overview report indicated the cattle and calves industry brought in $1.8 billion and cow milk another $44 million. There were 2.63 million cattle and calves in inventory. Volatile cattle and feed markets, as well as rising input costs, provide challenges to sustainable production. MSU Extension provides programming and resources so strongly desired by the industry that in 2013 producers lobbied the state legislature to fund a second beef cattle specialist. The second specialist completed her first full year in 2015.

What has been done
A new MSU Extension Beef Cattle Facebook page was created, 'The Cow Sense Chronicle' monthly newsletter was delivered and monthly updates were included in the Montana Stockgrowers update. Agents and specialists offered information through timely press releases, one-on-one visits, direct phone calls and email. They recorded radio spots, offered webinars and participated in broadcasts of Montana Ag Live on Montana PBS. Specialists visited 33 counties with 44 beef cattle programs including cattle nutrition, reproduction, industry outlook, weather-impacted forage, nitrate toxicity and more. Two specialists directly reached 2223 Montanans with timely, research-based and unbiased animal science education; and agents reached far more.

Results
Two new MontGuides were created and are in review. Overall, program participants rated classes 4.5 on a 5 point scale. When wet weather caused sprouted grains, ergot and wet hay, critical animal health information was released immediately via Facebook, a press release and an Ag Alert thereby reducing catastrophic cattle losses. Increased knowledge from various programs was reported as follows based on a scale of 1-5 poor to excellent: influence of Line 1 Herefords from 2.13 to 3.63; heifer development and lifetime reproductive success from 3.37 to 4.38; understanding cattle market trends from 3.29 to 4.43; managing livestock insect pests from 3.57 to 4.5 Ag safety risk management from 3.43 to 4.29 and managing rangelands to improve wildlife habitat from 2.9 to 3.9.

4. Associated Knowledge Areas

- ☑ 121 - Management of Range Resources
- ☑ 301 - Reproductive Performance of Animals
- ☑ 302 - Nutrient Utilization in Animals
- ☑ 303 - Genetic Improvement of Animals
- ☑ 305 - Animal Physiological Processes
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- ☐ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☐ 901 - Program and Project Design, and Statistics
- ☐ 902 - Administration of Projects and Programs
- ☑ 903 - Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☑ Appropriations changes
- ☑ Public Policy changes
- ☑ Government Regulations
- ☐ Competing Public priorities
- ☐ Competing Programmatic Challenges
- ☑ Populations changes (immigration, new cultural groupings, etc.)
- ☑ Other (high cost of fuel, fertilizer)

Brief Explanation

Extreme moisture during August and September caused significant risk for animal health as hay bales and forage became saturated. Extension worked tirelessly to educate producers on how to test moldy forage, what to test for and how to mitigate poor forage quality. Losses were reduced as a result though specific data was not collected.
The weather will always be a factor for livestock production and animal health. The national economy and various health-related issues play a role in the industry as more people

become interested in growing their own food, or concerned about how their food is grown. The generational shift in livestock production agriculture, as the population changes, is also a factor. Extension and MAES play a stabilizing role in the industry providing proactive solutions, and unbiased, science-based information.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The objectives for this program included seeking novel vaccines for prevention of livestock diseases, maintaining status as a leading university in animal production and animal health research, providing genomic research to help Montana producers stay competitive, producing safe, nutritious livestock products in sufficient quantity to meet demand, increasing profitability and increasing knowledge of environmentally sustainable practices as they relate to animal health. All these objectives have been met and are continuing to be priorities for the program going forward.

Key Items of Evaluation

- Citizens lobbied the legislature to fund a second Extension Beef Cattle Specialist
- Completed a study evaluating the potential anabolic activities of progesterone as related to differences in reproductive rates
- Completed a study of individual animal variation in extreme high and low RFT growing lambs
- Reported after slaughter organ weights, body composition and gene expression and carcass characteristics
- Presented results at the World Congress of Genetics Applied to Livestock Production and the National Animal Science Meeting
- Montana Wool Growers Young Producers Forum was formed
- Producers who attended seminars better understood regional and national issues facing the sheep and wool industry and utilized information on grazing hay aftermath and nutrition
- Researchers are currently testing if pre-treatment of calves with Acai PS will reduce disease and bacterial shedding following oral Salmonella infection
- Researchers determined the composition of cattle and sheep vaginal microbiota co-varies with reproductive performance
- Routes of transmission of early colonizing microbioata in livestock were found
- Microbes that correlate with indicators of reproductive performance, neonatal health and animal performance in livestock were identified
- Through programs and one-on-one visits, producers learned to make more informed decisions when purchasing supplemental feed or non-traditional feedstuffs and/or establishing ranch raised forages and concentrates
- By balancing rations, adjusting for antagonists and working through alternatives, producers improved animal health and increased profitability. Producers reported:
    - I saved $45/head and my cows are healthier
    - I saved 3% on my annual feed bill
    - I learned I could use potato tailings I had on hand rather purchasing a grain supplement.
- Participants at one Cattle School (n=48) increased their knowledge: Forage quality effects on herd management and nutrition from 3.56 to 4.30; water quality importance from 3.1 to 4.0

- Two new beef cattle MontGuides were created
- When wet weather caused sprouted grains, ergot and wet hay, critical animal health information was released immediately via Facebook, press release and an Ag Alert thereby reducing catastrophic cattle losses
- Increased knowledge from beef programming was reported based on a scale of 1-5 poor to excellent: influence of Line 1 Herefords from 2.13 to 3.63; heifer development and lifetime reproductive success from 3.37 to 4.38; understanding cattle market trends from 3.29 to 4.43; managing livestock insect pests from 3.57 to 4.5 Ag safety risk management from 3.43 to 4.29 and managing rangelands to improve wildlife habitat from 2.9 to 3.9.
- Progress and discovery in primary veins of infectious disease research included; emerging arthropod-vectored diseases of livestock and wildlife, molecular analysis of phagocyte chemotactic receptors in bovine phagocytes, analysis of gamma T and delta cells, exploring the role of microbitoa in animal nutrition, health and reproductive performance, carcass composition and meat quality, nutritional management of range and beef cows and salmonellosis in calves.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Plant and Soil Sciences

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	10%		0%	
104	Protect Soil from Harmful Effects of Natural Elements	5%		0%	
112	Watershed Protection and Management	15%		5%	
121	Management of Range Resources	10%		5%	
132	Weather and Climate	5%		5%	
135	Aquatic and Terrestrial Wildlife	0%		5%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		10%	
202	Plant Genetic Resources	0%		6%	
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%		5%	
204	Plant Product Quality and Utility (Preharvest)	10%		5%	
205	Plant Management Systems	10%		8%	
211	Insects, Mites, and Other Arthropods Affecting Plants	0%		5%	
212	Pathogens and Nematodes Affecting Plants	0%		5%	
213	Weeds Affecting Plants	0%		5%	
215	Biological Control of Pests Affecting Plants	0%		5%	
216	Integrated Pest Management Systems	0%		5%	
502	New and Improved Food Products	0%		8%	
601	Economics of Agricultural Production and Farm Management	20%		5%	
901	Program and Project Design, and Statistics	0%		3%	
903	Communication, Education, and Information Delivery	15%		5%	
	Total	100%		100%	

Add knowledge area

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	3.0	0.0	110.3	0.0
Actual Paid	5.2	0.0	107.4	0.0
Actual Volunteer	2.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
146965	0	1045752	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	4269528	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
99684	0	3307272	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Develop new crops and cultivars suitable to a warmer and drier climate
- Explore the ecological impact of climate change on Montana grazing areas
- Study the impact of a changing climate on insects
- Develop, enhance and distribute pest management programs
- Continue investigating crops and management systems that rely on less water consumption
- Meet one-on-one with producers, landowners and consumers to identify and address individual problems and solutions
- Encourage email and phone conversations with members of the public
- Offer classes, workshops, group discussions, demonstrations, field tours/trials, webinars
- Share information at farmer's markets, county fairs and other community events
- Attend and present information at professional conferences, county meetings and state conventions
- Prepare and distribute public service announcements, newsletters, MONTGuides, Television (Montana PBS Montana Ag Live), eXtension, listservs, blogs, radio and other media
- Create readily available and easily accessible databases for producers and researchers
- Prepare research articles, fact sheets and news releases for scientists and statewide media
- Host strategic planning meetings with state agricultural groups and Extension advisory groups
- Develop systems that ensure food safety and agricultural security
- Support FIFRA Section 18c products labeling requests
- Release germplasm, new cultivars, and new genomics tools and techniques
- Develop value-added, agriculturally based end-use products
- Enhance partnerships among faculty across Montana institutions, producers, agricultural industry and

other education institutions
- Enhance agricultural production practices to enhance product quality
- Investigate and educate producers on crops and management systems that consume less water

2. Brief description of the target audience

- Crop and livestock producers
- State agricultural advisory committees
- State and federal government agencies
- Commodity associations
- Weed control professionals and County Weed Boards
- Small acreage landowners
- Tribal councils and Native American producers
- Crop protection companies registration and research personnel
- Private and commercial pesticide applicators
- Domestic and foreign buyers of wheat
- Montana Wheat and Barley Committee, grain elevators operators

3. How was eXtension used?

Agents and specialist utilized eXtension to provide webinars and programming, share fact sheets, evaluate courses and programs (Moodle), conduct radio interviews, create Extension documents and as a general resource.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	28051	806392	5899	21479

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	37	1000	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research citations

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	1500

Output #2

Output Measure

- Number of producers attending workshops, field days, research plot sites, and research center summaries

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	33950

Output #3

Output Measure

- Number of people adopting conservation practices.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	4500

Output #4

Output Measure

- Number of producers using pulse crops in rotation

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	50000

Output #5

Output Measure

- Number of people participating in range monitoring programs and the Range Management Institute

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	50

Output #6

Output Measure

- Number of requests to identify or record new weeds and pests

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	2316

Output #7

Output Measure

- Number of people attending workshops, training and tours related to pesticide control and applicator training. Number of people being certified and re-certified for pesticide use.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	1329

Output #8

Output Measure

- Number of foreign trade teams

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	15

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Crops: Increase in number of producers who implement nutrient cycling, weed control, variety selection and alternative crop possibilities. Increase in number of farm operators who implement best practices to increase profitability and enhance long-term sustainability
2	Range: Increase in number of producers and small acreage landowners who are aware of the identification of a new insect, weed and disease infestations, and quickly identify new problems so they can make timely management decisions. Increase the number of producers/ranch managers who implement range monitoring activities which lead to improvement in resource management strategies.
3	Weed and Pest Control: Increase in the number of applicators who are certified and employ safety precautions and risk management strategies while using pesticides in the most environmentally and economically effective manner. Increased use of the Schutter Diagnostic Lab and specialists to identify pest, disease and plants in a timely manner and follow-up with appropriate recommendations.
4	Number of new stress tolerant crop recommendations or changes for Montana. Number of new or improved cultivar recommendations provided to Montana producers to maintain dominance in small grain markets
5	Number of new molecular techniques into breeding projects to improve outcomes
6	Increase average per bushel yield of Montana grains while maintaining product quality
7	Identify critical infection and disease resistance

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Crops: Increase in number of producers who implement nutrient cycling, weed control, variety selection and alternative crop possibilities. Increase in number of farm operators who implement best practices to increase profitability and enhance long-term sustainability

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	3807

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There are plant disease problems in Montana that are economically and socially detrimental. Education and research can help mitigate these issues and benefit Montana's $2.2 billion crop industry. The selection and spread of herbicide resistance, including multiple herbicide resistance, continues to be a major problem threatening the economic and environmental sustainability of Montana agriculture.

What has been done
Presentations, publications, media; grant applications, research, one-on-one visits and/or webinars are conducted in every county and on all reservations to connect the latest scientific knowledge and research specific to Montana's unique climate and environment directly with producers in a timely and efficient manner. At least 30 Extension programs were held, 8 episodes of Montana Live (80,000 viewers) and 16 AgAlerts were sent that directly addressed disease management in Montana crops.

Results
The risk period of wheat curl mite movement and infection of wheat in the fall was high due to an extended fall in early planted winter wheat. A record high of 89 samples were submitted for diagnosis of wheat streak mosaic virus to the Schutter Diagnostic Laboratory in 2015. Respondents to a survey (30 of 58 contacts) indicated the disease affected 159,310 acres and yields ranged from 25-150% of expected, with a mean of 85%. At an average yield of 45 bu/a and a price of $6/bu, this represents an estimated loss of $6.45 mil on those acres. Respondents increased their knowledge of wheat viruses (96%), and efforts to eliminate the green bridge for

disease management increased in 92% of respondents. The majority (76%) reported that fewer acres were affected by viruses due to the diagnostic services.

4. Associated Knowledge Areas

- ☐ 102 - Soil, Plant, Water, Nutrient Relationships
- ☐ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☑ 112 - Watershed Protection and Management
- ☐ 121 - Management of Range Resources
- ☐ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☐ 201 - Plant Genome, Genetics, and Genetic Mechanisms
- ☐ 202 - Plant Genetic Resources
- ☐ 203 - Plant Biological Efficiency and Abiotic Stresses Affecting Plants
- ☐ 204 - Plant Product Quality and Utility (Preharvest)
- ☑ 205 - Plant Management Systems
- ☐ 211 - Insects, Mites, and Other Arthropods Affecting Plants
- ☐ 212 - Pathogens and Nematodes Affecting Plants
- ☑ 213 - Weeds Affecting Plants
- ☐ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☐ 502 - New and Improved Food Products
- ☑ 601 - Economics of Agricultural Production and Farm Management
- ☐ 901 - Program and Project Design, and Statistics
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Range: Increase in number of producers and small acreage landowners who are aware of the identification of a new insect, weed and disease infestations, and quickly identify new problems so they can make timely management decisions. Increase the number of producers/ranch managers who implement range monitoring activities which lead to improvement in resource management strategies.

2. Associated Institution Types

- ☑ 1862 Extension

☑ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Pests such as orange wheat blossom midge can quickly invade large areas and cause tremendous economic loss. Rapid identification of invasions allows for timely management decisions that can lesson damages.

What has been done
The MSU Pestweb site (https://pestweb.montana.edu/cutworm/home) serves as an early warning system to help producers track insect emergence and distribution throughout the state of Montana on a field scale basis. The site was viewed over 11,000 times by over 500 users; an increase of 233% compared to last year. In 2015, 67 AgAlerts were delivered. AgAlerts go through a subscriber-based alert system that allows clients and interested parties to receive emails about issues, pests workshops and other informative emails regarding agriculture in Montana. The Montana AgAlert website (www.mtagalerts.org) had a 64% increase in visitors compared to last year (15,460 vs 9,435).

Results
Orange wheat blossom midge and cutworm traps were deployed by 57 volunteer cooperators (27 counties, 265 fields) and data uploaded to the MSU Pestweb. Information was made available in real-time to the general public so that small grain growers, county agents, research center staff and Extension specialists throughout the state were able to see if midge populations were present in their immediate area to determine if the number warranted scouting their fields and whether management was necessary. Staff also worked to develop trapping mechanisms and testing efficacy for wireworms, pea leaf weevil, wheat head armyworm, confused flour beetle, sawflies and flea beetles. The goal is to have push notifications and a web-based system for farmers similar to the scab project (www.scabusa.org)

4. Associated Knowledge Areas

☐ 102 - Soil, Plant, Water, Nutrient Relationships
☐ 104 - Protect Soil from Harmful Effects of Natural Elements
☑ 112 - Watershed Protection and Management
☑ 121 - Management of Range Resources

- ☐ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☐ 201 - Plant Genome, Genetics, and Genetic Mechanisms
- ☐ 202 - Plant Genetic Resources
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- ☐ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☐ 502 - New and Improved Food Products
- ☐ 601 - Economics of Agricultural Production and Farm Management
- ☐ 901 - Program and Project Design, and Statistics
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Weed and Pest Control: Increase in the number of applicators who are certified and employ safety precautions and risk management strategies while using pesticides in the most environmentally and economically effective manner. Increased use of the Schutter Diagnostic Lab and specialists to identify pest, disease and plants in a timely manner and follow-up with appropriate recommendations.

2. Associated Institution Types

- ☑ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This has been moved to the new program area: Integrated Pest Management

What has been done

Results

4. Associated Knowledge Areas

- ☐ 102 - Soil, Plant, Water, Nutrient Relationships
- ☐ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☐ 112 - Watershed Protection and Management
- ☐ 121 - Management of Range Resources
- ☐ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☐ 201 - Plant Genome, Genetics, and Genetic Mechanisms
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- ☑ 213 - Weeds Affecting Plants
- ☑ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☐ 502 - New and Improved Food Products
- ☑ 601 - Economics of Agricultural Production and Farm Management
- ☐ 901 - Program and Project Design, and Statistics
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #4

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Number of new stress tolerant crop recommendations or changes for Montana. Number of new or improved cultivar recommendations provided to Montana producers to maintain dominance in small grain markets

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	50

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Production agriculture, especially wheat and barley, is economically important for Montana. These commodities are grown over a vast and diverse land base and specific geographic areas face unique challenges to successful production. Experimental breeding lines and new stress tolerant crops are critical to addressing land use challenges and diverse climates. These lines must be evaluated under local conditions to identify which materials are best adapted to a given region and to develop more stress-tolerant cultivars. The ultimate goal is to provide Montana farmers with improved, high-yield varieties that are desirable to wheat breeders.

What has been done
The agronomic and economic impact of various crop sequences in dryland crop production in Montana was evaluated. Yield and profitability were the primary measures, but secondary to those were shifts in weed pressure, disease pressure and changes in soil quality and soil carbon status. New spring wheat varieties were grown on one million acres in 2015. 2015 provided further evidence of the importance of a dry early spring to foster winter canola survival. Economic risk of various small grains proved a soil-mediated agricultural resilience in long-term pea-wheat cropping systems.

Results
Several faculty contributed presentations to producers? conferences around the northern Plains region, including more than 500 attendees. New spring wheat varieties include key aspects of pest resistance and drought tolerance. Nurseries were grown to identify superior lines and crosses made in past years. These lines will be considered for release as new varieties. The first 2-year cycle of a multi-species cover crop study was completed. This year malt barley was grown following cover crop treatments of individual species as well as mixtures. A new high-amylose line of pea that is higher yielding and has higher amylose content than any previous MSU lines will be submitted for release.

4. Associated Knowledge Areas

- ☑ 102 - Soil, Plant, Water, Nutrient Relationships
- ☑ 104 - Protect Soil from Harmful Effects of Natural Elements

- ☐ 112 - Watershed Protection and Management
- ☐ 121 - Management of Range Resources
- ☑ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☑ 201 - Plant Genome, Genetics, and Genetic Mechanisms
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- ☑ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☑ 502 - New and Improved Food Products
- ☐ 601 - Economics of Agricultural Production and Farm Management
- ☐ 901 - Program and Project Design, and Statistics
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Number of new molecular techniques into breeding projects to improve outcomes

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	200

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The nature of the genetic mechanisms that regulate plant health and reproductive development is critical to crop production in Montana. These factors heavily influence agronomic yield and end product (the two most important factors affecting farmer income) quality of cereal crops such as wheat. End product quality is impacted by genes that influence seed development and determine seed composition and suitability for various end product applications. MSU recognizes and practices the newest methods and utilizes the latest tools for surgically manipulating DNA in plant genomes. The results of this work will provide a foundation for designing the next generation of tools for correcting genetic disorders and engineering agriculturally important products.

What has been done

New strategies for enhanced genome engineering in Ag related plant systems were discovered. The relationship between leaf starch synthesis and plant productivity was determined. Current molecular biology methods were used to identify mutations in genes affecting the hardness and milling efficiency of grain. Backcrossing of novel high molecular weight glutenin mutations into two adapted spring wheat parents were completed and stem solidness and agronomic traits were measured.

Results

A genome wide knockout library for phentotypic screening was developed and the library has been used to perform a gain of function screen using the Cas9/sgRNA system to identify genes associated with HDR. Studies were completed that demonstrated native leaf starch production levels limit plant growth more than native levels of seed starch. Wheat breeders selected varieties with improved agronomic and end level traits and pest resistance. New variants for the Puroindoline and Glutenin genes were created and documented.

4. Associated Knowledge Areas

- ☑ 102 - Soil, Plant, Water, Nutrient Relationships
- ☐ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☐ 112 - Watershed Protection and Management
- ☐ 121 - Management of Range Resources
- ☑ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
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- ☑ 213 - Weeds Affecting Plants
- ☑ 215 - Biological Control of Pests Affecting Plants
- ☐ 216 - Integrated Pest Management Systems
- ☑ 502 - New and Improved Food Products

- ☑ 601 - Economics of Agricultural Production and Farm Management
- ☐ 901 - Program and Project Design, and Statistics
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #6

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Increase average per bushel yield of Montana grains while maintaining product quality

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◉ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agronomic yield and end product quality of cereal crops such as wheat are the two most important factors affecting farmer income. Total agronomic yield in cereals is a function of the amount of carbon fixed in leaves and ultimately stored and harvested in seeds.

What has been done
Starch in cereals typically consists of 25% amylose and 75% amylopectin. Amylose is less easily digested by humans. Decreased ease of digestion equates to a low net carb effect in high amylose wheat-based foods. Aside from health effects, high amylose wheat flour would improve the end product quality of pasta as it would be firmer and more resistant to degradation during cooking. MSU Researchers have designed experiments focused on the development of high amylose durum wheat that would have enhanced health attributes, firmness and consumer acceptance.

Results
Researchers completed field and end product quality studies on durum with increased amylose. The project identified genotypes useful in the creation of high amylose durum and reduced glycemic index food products. Researchers demonstrated that increased amylose durum is pronounced in having enhanced nutritional properties such as increased dietary fiber and protein content. Researchers expanded this objective to include the development of specific levels of

amylose in bread wheat and published a paper describing that allelic variation in wheat grain hardness alleles leads to end product quality differences with hardness highly correlated with break and total flour yield. Several lines having unique grain hardness and milling properties will be the focus of future releases.

4. Associated Knowledge Areas

- ☐ 102 - Soil, Plant, Water, Nutrient Relationships
- ☐ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☐ 112 - Watershed Protection and Management
- ☐ 121 - Management of Range Resources
- ☐ 132 - Weather and Climate
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- ☐ 216 - Integrated Pest Management Systems
- ☐ 502 - New and Improved Food Products
- ☐ 601 - Economics of Agricultural Production and Farm Management
- ☐ 901 - Program and Project Design, and Statistics
- ☐ 903 - Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

☑ Not Reporting on this Outcome Measure

Identify critical infection and disease resistance

2. Associated Institution Types

- ☑ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
This has been moved under the program Integrated Pest Management

What has been done

Results

4. Associated Knowledge Areas

- ☐ 102 - Soil, Plant, Water, Nutrient Relationships
- ☐ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☐ 112 - Watershed Protection and Management
- ☑ 121 - Management of Range Resources
- ☐ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
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- ☑ 216 - Integrated Pest Management Systems
- ☑ 502 - New and Improved Food Products
- ☐ 601 - Economics of Agricultural Production and Farm Management
- ☐ 901 - Program and Project Design, and Statistics
- ☑ 903 - Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☑ Appropriations changes
- ☑ Public Policy changes
- ☑ Government Regulations
- ☐ Competing Public priorities
- ☐ Competing Programmatic Challenges
- ☐ Populations changes (immigration, new cultural groupings, etc.)
- ☑ Other (High cost of fuel, fertilizer)

Brief Explanation

Crop production is solely dependent upon landscape response to climate and favorable conditions to all crop varieties. These include; pest control, water, soil health and strong international markets for the agricultural sector. Market conditions in agricultural markets, commodity pricing, farmer income and profitability are greatly impacted by factors beyond human control, leaving those who depend on these resources challenged to develop flexible management plans that ensure resiliency, viability and profitability.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

This program area meet its objectives in the application of Montana farmers choosing to grow MSU varieties that were specifically developed for Montana's local conditions and by the healthy and robust small grains market of Montana producers. USDA statistics show that Montana planted 5.8 million acres of wheat this year, with 2.2 million acres of spring and winter wheat varieties developed by MAES. MSU wheat varieties accounted for approximately $500 million of $1.2 billion wheat sold by Montana farmers in 2015. Some wheat varieties developed by MSU are sold by private companies. Montana exports 20 percent of agricultural products as foreign exports and 75 percent of its wheat to Asian markets, according to the USDA.
2.4 million acres of winter wheat were planted across Montana this year. MAES winter wheat varieties accounted for 59 percent, or 1.4 million acres of total planted winter wheat acreage across the state. The top-seeded varieties were Yellowstone, Judee and Decade, respectively.
2.6 million acres of spring wheat were planted across Montana this year, with 32 percent, or 810,000 acres, seeded with a MAES-developed spring wheat variety. For the fifth year in a row, Vida, a hard-red spring wheat developed by MAES, was the most commonly planted spring wheat across the state. Vida accounted for 16.8 percent of all planted spring wheat in 2015, while additional MAES spring wheat varieties accounted for 13.2 percent.

Key Items of Evaluation

- A record 89 samples of wheat streak mosaic virus were submitted to the Schutter

Diagnostic Laboratory in 2015

- Survey respondents (30 of 58 contacts) indicated the disease affected 159,310 acres and yields ranged from 25-150% of expected, with a mean of 85%. At an average yield of 45 bu/a and a price of $6/bu, this represents an estimated loss of $6.45M.
- Respondents increased knowledge of wheat viruses (96%), and efforts to improve disease management increased 92%.
- 76% reported the diagnostic services resulted in fewer affected acres
- MSU Pestweb site was viewed 11,000+ times (233% more than 2014)
- 67 AgAlerts were delivered through the Montana AgAlert website (visitors increased 64% from 9,435 to 15,460)
- Orange wheat blossom midge and cutworm traps were deployed by 57 volunteers (27 counties, 265 fields) and data uploaded to MSU Pestweb.
- Information was made available to the public in real-time so producers and educators statewide could see if midge populations were present in their immediate area and determine if scouting their fields and/or further management was needed.
- Staff worked to develop trapping mechanisms and testing efficacy for wireworms, pea leaf weevil, wheat head armyworm, confused flour beetle, sawflies and flea beetles.
- New spring wheat varieties which included key aspects of pest resistance and drought tolerance were grown on a million acres in 2015.
- Nurseries were grown to identify superior lines and crosses which will be considered for release as new varieties.
- The first 2-year cycle of a multi-species cover crop study was completed.
- In 2015 malt barley was grown following cover crop treatments of individual species as well as mixtures.
- A new high-amylose line of pea that is higher yielding and has higher amylose content than any previous MSU lines will be submitted for release.
- New strategies for enhanced genome engineering in Ag related plant systems were discovered.
- Current molecular biology methods were used to identify mutations in genes affecting the hardness and milling efficiency of grain.
- Backcrossing of novel high molecular weight glutenin mutations into two adapted spring wheat parents were completed and stem solidness and agronomic traits were measured.
- A genome wide knockout library for phentotypic screening was developed and the library has been used to perform a gain of function screen using the Cas9/sgRNA system to identify genes associated with HDR.
- Studies were completed that demonstrated native leaf starch production levels limit plant growth more than native levels of seed starch.
- New variants for the Puroindoline and Glutenin genes were created and documented.
- Researchers completed field and end product quality studies on durum with increased amylose:
- Identified genotypes useful in the creation of high amylose durum and reduced glycemic index food products.
- Demonstrated that increased amylose durum has enhanced nutritional properties such as increased dietary fiber and protein content.
- Published a paper describing that allelic variation in wheat grain hardness alleles leads to end product quality differences with hardness highly correlated with break and total flour yield.

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Farm and Ranch and Business Management

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
112	Watershed Protection and Management	5%		0%	
121	Management of Range Resources	5%		5%	
307	Animal Management Systems	5%		0%	
601	Economics of Agricultural Production and Farm Management	30%		45%	
602	Business Management, Finance, and Taxation	5%		20%	
609	Economic Theory and Methods	5%		10%	
610	Domestic Policy Analysis	5%		5%	
611	Foreign Policy and Programs	0%		10%	
903	Communication, Education, and Information Delivery	40%		5%	
	Total	100%		100%	

Add knowledge area

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	1.5	0.0	13.5	0.0
Actual Paid	4.2	0.0	15.0	0.0
Actual Volunteer	1.5	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
83391	0	372717	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1089203	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
234774	0	365512	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

MSU researchers and Extension agents will work one on one and in groups with producers, landowners and consumers to identify and address individual and industry challenges and solutions. They will regularly answer specific questions through workshops, phone calls, email and personal consultations. Agents and specialists will also offer classes, workshops, group discussions, demonstrations, field tours/trials and more. Agents, specialists and volunteers disseminate knowledge at every available chance via community events and meetings. MSU Extension utilizes PSA's, newsletters, MONTGuides, television, eXtension, listserves and other media. Additional activity priorities include:

Publish peer reviewed articles contributing to the field
Create and maintain outreach programs
Provide improved information and research in relation to farm and ranch management
Contribute to the understanding of complicated financial and management decisions
Provide informational trainings and programs related to environment

2. Brief description of the target audience

- Farmers/Ranchers/Ag producers
- Land Managers/Owners
- Livestock/Crop producers and related stakeholders
- Private forest land owners and public land managers
- Small acreage land owners
- Tribal farm and ranch community
- Economists

3. How was eXtension used?

eXtension was used for general resources and for planning and evaluation tools. Specialists answer questions that are asked through "Ask an Expert".

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	6939	12800	285	1000

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2015

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	12	10	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Provide transformational research and education to producers through outreach and Extension programs.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #2

Output Measure

- Publish research in peer-reviewed, scientific journals

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	22

Output #3

Output Measure

- Present research findings to the public and interested producers through seminars and workshops

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	100

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of new or improved management recommendations provided to and adopted by Montana producers.
2	Increase in number of producers, small and large acreage landowners who are aware of current programs and information related to farm and ranch business management, and make timely management decisions as a result.
3	Increase in number of producers/farm and ranch managers who implement range monitoring activities which lead to improvement in resource management strategies.

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Number of new or improved management recommendations provided to and adopted by Montana producers.

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	300

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Montana stakeholders have frequently requested better information and analysis on the topic of leasing agricultural lands.

What has been done
A comprehensive program is being designed to meet the needs of stakeholders. So far a website was created that includes short webinars, links to MONTGuides, presentations, handouts and other resources. The program will soon include face-to-face workshops, interactive tools and additional resources on lease rates and types that are presented in an easy-to-understand manner.

Results
The website became active in October and received 300 hits by December despite not being promoted. The website prompted additional requests for programming beyond those initially planned. This program will grow to meet the demand of Montana stakeholders.

4. Associated Knowledge Areas

☑ 112 - Watershed Protection and Management
☑ 121 - Management of Range Resources
☐ 307 - Animal Management Systems
☐ 601 - Economics of Agricultural Production and Farm Management

- ☐ 602 - Business Management, Finance, and Taxation
- ☐ 609 - Economic Theory and Methods
- ☐ 610 - Domestic Policy Analysis
- ☐ 611 - Foreign Policy and Programs
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Increase in number of producers, small and large acreage landowners who are aware of current programs and information related to farm and ranch business management, and make timely management decisions as a result.

2. Associated Institution Types

- ☑ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	6397

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Agricultural Act of 2014, commonly known as the Farm Bill, is very complex legislation that created questions and concerns by farmers, ranchers, bankers and others working in agriculture-related business regarding how it would impact them and their profitability. Major constituent groups including the Montana Grain Growers Association, the Montana Farm Bureau and the Montana Farmer's Union asked MSU Extension to provide educational tools and assistance to help producers understand insurance options and other relevant features.

What has been done
Extensive Farm Bill Education was offered from October 15, 2014-March 31, 2015. Over 4,000 farmers and other interested parties attended 85 presentations (3 train-the-trainer, 14 webinar, 68 face-to-face). Fourteen of the presentations were held on Reservations and seven of the webinars were designed specifically for Native American communities. The Native American website was viewed by 355 users and the general website by 2,272 users.

Results

Results were measured through post presentation surveys. Respondents (n=1288) were 97% white despite significant efforts to reach Native Americans. Prior to the session, 26% felt confident describing the price loss coverage (PLC) program; 23% the agricultural risk coverage (ARC) program, 21% the supplemental coverage option (SCO), and 21% the farm bill decision tools. More than 95% indicated their knowledge about PLC, ARC and the decision tools increased significantly or very significantly; and 88% about SCO. Overall 92% were satisfied with the seminar and 98% said they would recommend it to others. A small sample (n=56) contacted after the season indicated: 85% used the workshop to make a choice between PLC,ARC and SCO; 48% used the APAS Decision tool and of those 88% said it was very helpful. Seventy-five percent of those who used the MSU calculator said it was useful. Based on the 56 observations it appeared the increase in net profit would be about $2,650/person attending. If this were extrapolated to the 3,770 total attendees the added value would be $9.99 million.

4. Associated Knowledge Areas

- ☐ 112 - Watershed Protection and Management
- ☐ 121 - Management of Range Resources
- ☐ 307 - Animal Management Systems
- ☑ 601 - Economics of Agricultural Production and Farm Management
- ☑ 602 - Business Management, Finance, and Taxation
- ☐ 609 - Economic Theory and Methods
- ☐ 610 - Domestic Policy Analysis
- ☐ 611 - Foreign Policy and Programs
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Increase in number of producers/farm and ranch managers who implement range monitoring activities which lead to improvement in resource management strategies.

2. Associated Institution Types

- ☑ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	3806

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Rangelands comprise 70% of Montana?s 93 million acres, including much of what makes Montana a special place, including clean air and water, scenic open spaces, and abundant wildlife. Rangelands also support Montana?s second largest industry ? range-livestock agriculture (second to cropland agriculture). Rangeland management issues include: invasive plants; livestock grazing conflicts with fish, wildlife and recreation; increased food and fiber demands; conversion of rangelands to croplands and/or residential areas; and pressure to reduce greenhouse gas emissions and use of water and energy.

What has been done
The rangeland specialist taught 20 non-credit instruction events and worked with 65 individuals one-on-one for a total of 2406 direct educational contacts. The rangeland weed specialist gave 29 presentations, held a 3-day weed management workshop, appeared on Montana Ag Live 7 times and distributed 12 monthly weed posts.

Results
Created the first annual College of Agriculture and Extension Research Report as a way to better connect faculty and researchers on campus with faculty in the field. Specialists published 16 Extension/outreach publications, six peer-reviewed journal articles on applied research, one book chapter and one article in the first annual College of Agriculture and Extension Research Report. Weed presentations earned a 4.88 on a scale of 1 (poor) to 5 (excellent). Participants indicate that they better understood the biology and ecology of invasive plants on Montana's range and wildlands and are better able to manage them effectively.

4. Associated Knowledge Areas

- ☐ 112 - Watershed Protection and Management
- ☐ 121 - Management of Range Resources
- ☐ 307 - Animal Management Systems
- ☑ 601 - Economics of Agricultural Production and Farm Management
- ☑ 602 - Business Management, Finance, and Taxation
- ☐ 609 - Economic Theory and Methods
- ☐ 610 - Domestic Policy Analysis
- ☐ 611 - Foreign Policy and Programs
- ☑ 903 - Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☑ Appropriations changes
- ☑ Public Policy changes
- ☑ Government Regulations
- ☑ Competing Public priorities
- ☑ Competing Programmatic Challenges
- ☐ Populations changes (immigration, new cultural groupings, etc.)
- ☐ Other

Brief Explanation

In Montana and throughout the United States, market conditions, government policy and international and domestic policy decisions and fluctuations affect every aspect of agricultural and natural resource economic activity and, directly and indirectly, all aspects of the lives of people who live in rural communities. These polices have impacts on consumer welfare, producer welfare and the welfare of farm input suppliers and food processors, rural communities and tax payers.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Goals of the outcomes were accomplished as data and discovery led to more than 20 peer-reviewed articles, more than a dozen extension programs, a book chapter, two master's theses and fourteen outreach publications were produced. Additionally, faculty attended eight conferences and programs and presentations reached more than 400 producers (of which 15 percent are minority and limited resource producers). Data from this research was also provided as briefings to Congressional staffers, state and federal policy makers, agribusinesses leaders and county officials. The outcomes associated herein examine the effects on the natural resource base and economic welfare of ranches, agri-businesses and rural communities in the United States, Montana and developing countries of agricultural commodity policies, agricultural trade policies, natural resource and environmental policies, and agricultural science policies. Several of the areas of research within these outcomes are supported by external funds and involve collaboration with federal and state agencies and other universities.

Key Items of Evaluation

- Examined the effects of current and proposed changes to major commodity, disaster aid, conservation and agricultural insurance programs
- Investigated the implication of agricultural insurance based risk managing policies for farmers in developing countries
- Provided detailed analysis of the economic impacts of the BLM's wild horse and burrow program

- Investigated the economic factors that impact the development of pollination markets, affect trade-offs made by bee keepers between honey production and the provision of pollination services, and the economic impacts of CCD.
- Examined the evolution of property rights and behavior of tribal and non-tribal fishers following the BOLDT/PNW tribal natural resource management practices court decision in US vs. Washington.
- Investigated opportunities and costs of energy development on agricultural and other natural resources
- Crop insurance research was conducted; included the examination and modeling of potential whole farm insurance products, potential weather derivatives and effectiveness
- A large scale historical weather data set was developed and maintained
  - contains spatially and temporally indexed daily temperature and precipitation data from over 90,000 world-wide locations including 60,000 locations in Canada and US for the period 1850-2015.
- Research with respect to comparative farm level technical, financial, and economic efficiency benchmarks was conducted using regional and farm level data from the northern High Plains.
- Farm Bill Education was offered from October 2014-March 2015.
  - 4,000 participants attended 85 presentations
    - 14 presentations were held on Reservations and 7 webinars were designed specifically for Native American communities.
  - The Native American website was viewed by 355 users and the general website by 2,272 users.
  - Results were measured through post presentation surveys.
    - Prior to the session, 26% felt confident describing the price loss coverage (PLC) program; 23% the agricultural risk coverage (ARC) program, 21% the supplemental coverage option (SCO), and 21% the farm bill decision tools.
    - 95% indicated their knowledge about PLC, ARC and the decision tools increased significantly or very significantly; and 88% about SCO.
    - 92% were satisfied with the seminar and 98% said they would recommend it
  - A small sample (n=56) contacted after the season indicated:
    - 85% used the workshop to make a choice between PLC,ARC and SCO;
    - 48% used the APAS Decision tool and of those 88% said it was very helpful.
    - 75% who used the MSU calculator said it was useful.
    - Based on the 56 observations, it appeared the increase in net profit would be about $2,650/person attending. If this were extrapolated to the 3,770 total attendees the added value would be $9.99 million.
- Created the first annual College of Agriculture and Extension Research Report as a way to better connect faculty and researchers on campus with faculty in the field.
- Weed presentations earned a 4.88 on a scale of 1 (poor) to 5 (excellent). Participants indicate that they better understood the biology and ecology of invasive plants on Montana's range and wildlands and are better able to manage them effectively.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Integrated Pest Management

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
211	Insects, Mites, and Other Arthropods Affecting Plants	0%		10%	
212	Diseases and Nematodes Affecting Plants	10%		10%	
213	Weeds Affecting Plants	15%		10%	
214	Vertebrates, Mollusks, and Other Pests Affecting Plants	0%		10%	
215	Biological Control of Pests Affecting Plants	15%		10%	
216	Integrated Pest Management Systems	25%		16%	
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals	0%		10%	
601	Economics of Agricultural Production and Farm Management	5%		5%	
603	Market Economics	0%		5%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	5%		5%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	0%		5%	
721	Insects and Other Pests Affecting Humans	0%		2%	
903	Communication, Education, and Information Delivery	25%		2%	
	Total	100%		100%	

Add knowledge area

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

Actual Paid	8.0	0.0	93.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
131358	0	578858	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	3434999	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
296961	0	3501706	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• Met one-on-one with producers, landowners and consumers to identify and address individual problems and solutions
• Encouraged email and phone call conversations with the public
• Offered classes, workshops, group discussions, demonstrations, field tours/trials, webinars
• Shared information at farmers markets, county fairs and other community events
• Attended and presented information at professional conferences, county meetings and state conventions
• Prepared and distributed public service announcements, newsletters, MONTguides, Television (Montana PBS Montana Ag Live), eXtension, listservs, social media, radio and other media
• Created readily available and easily accessible databases for producers and researchers
• Prepared research articles, fact sheets and news releases for scientists and statewide media
• Hosted strategic planning meetings with state agricultural groups
• Developed systems that ensure food safety and agricultural security
• Integrated best practices for pests and disease management in parallel programs

2. Brief description of the target audience

• Agricultural producers in Montana facing current and future threats relating to invasive plants, plant diseases and pests.
• University faculty scientists conducting research in IPM
• Extension outreach personnel and statewide agents
• University economic development research programs
• Montana USDA state statistician and agricultural economics faculty
• Montana grain producers and associated committees, groups, and boards

3. How was eXtension used?

eXtension was used for evaluation and planning tools.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	8589	0	675	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2015

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	28	500	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of participants at Extension programs focused on management of diseases in Montana crops

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	2443

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increase in the number of private applicators who are certified and employ safety precautions and risk management strategies while using pesticides in the most environmentally and economically effective manner.
2	Increased use of the Schutter Diagnostic Lab and specialists to identify pest, disease and plants in a timely manner and follow-up with appropriate recommendations.
3	Conduct research on comparative agricultural and biological risk assessment
4	Develop Integrated Weed Management (IWM) strategies
5	Conduct research to increase knowledge that will be used to improve the integrated management of rangeland invasive plants
6	Improve knowledge and tools to improve disease management tools for Montana sugarbeet and potato growers.
7	Develop improved biological control programs for insects in the Western Triangle Agricultural Area

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Increase in the number of private applicators who are certified and employ safety precautions and risk management strategies while using pesticides in the most environmentally and economically effective manner.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1329

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The MSU Pesticide Education Program provides training and program licensing to approximately 6,100 private applicators across Montana. According to a Memorandum of Understanding between the Montana Department of Agriculture and MSU Extension, MSU Extension is responsible for managing the private applicator program. Without this license, producers could lose the ability to manage pest outbreaks thus causing significant revenue losses. The program also trains applicators in non-target toxicity, security of pesticides, and the safe and effective use of pesticides to minimize negative environmental impacts and poisonings across the state.

What has been done
Delivered 40 presentations statewide in seven core subject areas. Focused on educating applicators on how to calibrate sprayers as failure to do so often causes non-target toxicity while costing money. Other classes included: Pesticide Safety and Toxicity; Pesticide Movement in the Environment; Pesticide Performance and Water Quality; Reading, Understanding and Following the Product Label and Selecting Appropriate Nozzels.

Results
The presentation titled "Storage and Security of Pesticides" took place at 9 locations to approximately 200 farm and commercial pesticide applicators. Only 38% of participants indicated they secured their pesticides prior to the program, however 75% indicated they would secure pesticides as a result of the presentation.
The presentation titled "Pesticide Performance and Water Quality" was given at 4 locations to 100 applicators. Only 12% indicated they tested the pH of their water even when using highly

susceptible weak acid pesticides prior to the program; by programs end, 94% indicated they would test.
The presentation titled "Calibrating Sprayers Using Shortcut Methods" was delivered in 3 locations to 63 applicators. To begin only 43% could calibrate their sprayer; by the end 97% were able to calibrate their own sprayer.

4. Associated Knowledge Areas

- ☐ 211 - Insects, Mites, and Other Arthropods Affecting Plants
- ☐ 212 - Diseases and Nematodes Affecting Plants
- ☐ 213 - Weeds Affecting Plants
- ☐ 214 - Vertebrates, Mollusks, and Other Pests Affecting Plants
- ☑ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☐ 314 - Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards
- ☐ 601 - Economics of Agricultural Production and Farm Management
- ☐ 603 - Market Economics
- ☐ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 712 - Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Increased use of the Schutter Diagnostic Lab and specialists to identify pest, disease and plants in a timely manner and follow-up with appropriate recommendations.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2979

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Schutter Diagnostic Laboratory is provided as a service to the citizens of Montana through MSU and MSU Extension to provide plant pest identification. Services of the SDL include identification of plant diseases, insects, insect damage, weeds and other plants, abiotic problems and mushrooms. In addition, the SDL works to minimize pesticide use by accurately identifying plant pests and providing science based options for management.

What has been done
During 2015 the SDL performed 2,979 diagnoses (or identifications) on 2,107 diseases, insect and plant samples collected from 55 Montana counties and 10 additional states. The majority of samples came from homeowner/home gardeners (682). Of the samples, 37.9% were insect/spider identifications.

Results
A comprehensive survey in 2015 found that clients viewed the SDL as profoundly necessary and complementary to other sources used by clients. Ninety-nine percent of respondents rated SDL services as highly valuable to somewhat valuable in solving plant related problems. Ninety-seven percent were very satisfied to somewhat satisfied with SDL response. Eighty-eight percent of clients indicated they received educational information in addition to their diagnosis recommendations. Ninety three percent of respondents said that the SDL influenced their pest management decisions by giving them proper information about the environment and helping them reduce spread of the pest due to increased knowledge. The estimated monetary value of SDL based on responses from 489 clients was over $2 million.

4. Associated Knowledge Areas

- ☐ 211 - Insects, Mites, and Other Arthropods Affecting Plants
- ☑ 212 - Diseases and Nematodes Affecting Plants
- ☑ 213 - Weeds Affecting Plants
- ☐ 214 - Vertebrates, Mollusks, and Other Pests Affecting Plants
- ☑ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☐ 314 - Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards
- ☑ 601 - Economics of Agricultural Production and Farm Management
- ☐ 603 - Market Economics
- ☑ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 712 - Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Conduct research on comparative agricultural and biological risk assessment

2. Associated Institution Types

☐ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Current and proposed work on comparative risk assessment of insect disease vectors and associated management tactics helps define the risks and benefits of integrated vector management. The research has tremendous potential to influence public policy regarding the future conduct of biological control of insects. The influence of environmental factors, including temperature, on efficacy of insecticides for insect vectors of disease has important implications for insect management in an era of anthropogenic global warming.

What has been done
Research was focused on comparative agricultural and biological risk assessment. For ten years work has been done to estimate and compare risks among contemporaneous risk factors. Numerous scientific articles have been published. Over the next five years research will be focused in pest management and risk assessment, invasive species risk assessment, demography and mortality risk estimation for insect populations and efficacy factors for adult mosquito management. Research into how meteorological factors impact ultra-low-volume insecticidal application and how ambient temperatures alter the susceptibility of adult female mosquitoes to pyrethroid insecticides has been initiated.

Results
Ecological and human-health risk assessments of emerging infectious diseases and insecticides used to control disease vectors revealed science-based risks, as well as uncertainty and variability associated with each risk type. Toxicology research revealed the relationship between increasing ambient temperatures and mosquito mortality to pyrethroid insecticides. One journal article was published on this topic. Research continued on pesticide drift reduction technologies

and ecological risk assessment. Research also continued on the effects of genetically engineered insect resistant crops on non-target beneficial insects; and on mortality risks of insects using life-table approaches (two journal articles were published on this topic).

4. Associated Knowledge Areas

- ☐ 211 - Insects, Mites, and Other Arthropods Affecting Plants
- ☐ 212 - Diseases and Nematodes Affecting Plants
- ☐ 213 - Weeds Affecting Plants
- ☐ 214 - Vertebrates, Mollusks, and Other Pests Affecting Plants
- ☑ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☐ 314 - Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards
- ☐ 601 - Economics of Agricultural Production and Farm Management
- ☐ 603 - Market Economics
- ☑ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 712 - Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☐ 903 - Communication, Education, and Information Delivery

Outcome #4

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Develop Integrated Weed Management (IWM) strategies

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Developing integrated weed management (IWM) strategies, utilization of herbicide-resistant crops, and weed control solutions for new crops are critical for the diversification of agriculture in Montana. Research aimed at developing IWM strategies is needed to reduce on-farm weed control failures and manage or prevent the occurrence of herbicide resistance issues in dryland and irrigated cropping systems. A key focus is assessing weed populations for herbicide resistance and evaluating short- and long-term impact of current weed management tactics on herbicide resistant weed development. This research will lead to enhanced profitability and sustainability of the region?s agricultural production systems.

What has been done
A field study was conducted to understand seedling emergence patterns of increasingly herbicide-resistant Kochia. Another field study compared the growth characteristics of nine Kochia accessions from the Northern and Central Great Plains. A survey of multiple herbicide-resistant Kochia from wheat-fallow fields in Montana was conducted.

Results
Nine Kochia accessions were included in the field study. Emergence varied significantly with the highest emergence in North Dakota and Hays, KS accessions; and the least emergence in Manhattan, KS accessions. Forecasting seedling emergence patterns helps producers make proactive decisions for managing the region?s herbicide-resistant Kochia. The second field study found that Kochia accessions ranged from 150,000 to >500,000 seeds per plant in the non-competitive environment. This research demonstrated the need for location (environment)-specific biological data for management of Kochia with wide morphological, biological, or genetic traits. The survey found three Kochia populations from Toole county that were confirmed with two-way multiple resistance and two populations were confirmed with three-way resistance ? demonstrating further need for improved management.

4. Associated Knowledge Areas

- ☐ 211 - Insects, Mites, and Other Arthropods Affecting Plants
- ☐ 212 - Diseases and Nematodes Affecting Plants
- ☑ 213 - Weeds Affecting Plants
- ☐ 214 - Vertebrates, Mollusks, and Other Pests Affecting Plants
- ☑ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☐ 314 - Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards
- ☑ 601 - Economics of Agricultural Production and Farm Management
- ☐ 603 - Market Economics
- ☐ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 712 - Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Conduct research to increase knowledge that will be used to improve the integrated management of rangeland invasive plants

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◉ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Invasive weeds threaten rangeland health. Ecological impacts include altered structure, organization, and function of rangeland plant communities. Economically, weeds impact rangeland more than all other pests combined, including billions of dollars spent on control and reduction in livestock and wildlife carrying capacity. Containing existing populations and restoring rangeland severely degraded by weeds is critical for the ecology and economics of Montana agriculture and protection of its valuable natural resources.

What has been done
Downy brome is one of the most noteworthy plant invasions in North America, yet biological control is currently not available. Tall buttercup reduces grazing capacity as it is usually avoided by livestock and wildlife. Research has been done to quantify the impact of planting time on the establishment of native grasses, measure plant community response to invasive plant control and determine thresholds for natural recovery versus active revegetation. Additionally, research is being done that will increase understanding of the ecology and integrated management of downy brome by testing the integration and implementation of Pyrenophora semeniperda as a biological control; and of tall buttercup seedling emergence and growth by testing the effect of soil moisture.

Results
Knowledge was gained related to revegetation outcomes, specifically combinations of herbicides and seeding that restore rangeland dominated by spotted knapweed and downy brome. The results were presented in a peer-reviewed journal article. Three field studies and one greenhouse study investigated the use of a fungal pathogen to control downy brome. One peer-reviewed journal article was published. Pyrenophora semeniperda (PYSE) was tested as a biological

control for downy brome. Initial data suggests that PYSE had no effect on downy brome growth. However, the study revealed more about how to improve methods for revegetating invasive plant infested rangeland. Results from the revegetation studies are being analyzed and will be used to create a decision-support tool that land managers can use to help determine whether simply controlling weeds might lead to a desired plant community or if revegetation is necessary.

4. Associated Knowledge Areas

- ☐ 211 - Insects, Mites, and Other Arthropods Affecting Plants
- ☑ 212 - Diseases and Nematodes Affecting Plants
- ☑ 213 - Weeds Affecting Plants
- ☐ 214 - Vertebrates, Mollusks, and Other Pests Affecting Plants
- ☑ 215 - Biological Control of Pests Affecting Plants
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- ☐ 603 - Market Economics
- ☐ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 712 - Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #6

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Improve knowledge and tools to improve disease management tools for Montana sugarbeet and potato growers.

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is a need for improved disease management tools for Montana sugarbeet and potato growers. Tools are needed to address biological control agents, cultural controls, disease resistant cultivars and pesticides; as well as to integrate all of these into comprehensive disease management programs that focus on minimizing pesticide use and maximizing profitability.

What has been done
Extensive work has been done over many years to develop integrated management strategies for Rhizoctonia black scurf, silver scurf, black dot root rot, Verticillium wilt, scat, Sclerotinia white mold, leak, soft rot, Fusarium dry rot, potato virus Y of potato and Cercospora leaf spot, Rhizoctonia crown and root rot, Aphanomyces black root, and Fusarium yellows and curly top of sugar beet that incorporate biologically-based, genetic resistance and modern crop protectant products. In addition, there have been efforts to develop an understanding of the ecology and mode of action of Bacillius sp. biological control agents identified in the project, as well as of other crop systems where BmJ, Bm203-7, or other Bacillus sp. might provide control.

Results
Bacillus mycoides isolate J registration information has been completed by CERTIS USA for the USA and Canada. Full label acceptance is expected early 2016. Publications have been developed and presentations made on applications for potato early blight, Sclerotinia white mold, sugarbeet Cercsopora leaf spot and wheat fusarium crown rot. Temperature parameters for screening for Fusarium yellow have been published.

4. Associated Knowledge Areas

- ☐ 211 - Insects, Mites, and Other Arthropods Affecting Plants
- ☑ 212 - Diseases and Nematodes Affecting Plants
- ☑ 213 - Weeds Affecting Plants
- ☐ 214 - Vertebrates, Mollusks, and Other Pests Affecting Plants
- ☑ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☐ 314 - Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards
- ☑ 601 - Economics of Agricultural Production and Farm Management
- ☐ 603 - Market Economics
- ☑ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 712 - Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #7

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Develop improved biological control programs for insects in the Western Triangle Agricultural Area

2. Associated Institution Types

- ☑ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Wheat is the major food grain produced in the United States. The wheat stem sawfly, Cephus cinctus is a major pest infesting both winter and spring wheat in the Golden Triangle. Two species of wireworms, Limonius californicus and Hypnoidus bicolor, were recently found to be serious pests infesting wheat and barley. All these species cause millions of dollars of damage. Biological control programs with entomopathogens, pheromone-based trapping techniques to improve the capture efficiency of wheat stem sawfly, and the role of nutrients in C. cinctus management must be investigated to provide better integrated pest management and increased profitability and environmental sustainability.

What has been done
Evaluating nematodes and entomopathogens as biological control agents is under way and is aimed at developing microbial pesticides as practical tools for C. cinctus. Tests to determine the most optimal trapping technique for C. cinctus, including influence of trap type, size and color on the number of trap catches were completed. Field studies were conducted to evaluate various types of pheromone baited traps with different sizes and eight different colors to determine whether any visual cues affected trap catches.

Results
The mean trap catches of wheat stem sawfly by various colored pheromone traps did not differ from each other in either of two locations. Colored traps caught more sawflies than the bucket trap and the delta trap. In fact, bucket traps and delta traps caught next to no sawflies over the course of the study. Unbaited bucket pitfall traps were the only traps to catch click beetles. Entomopathogenic nematode strains mixed with water as well as Barricade were applied on wheat stubble of eight different hollow-stem varieties. Results showed no significant difference in the number of dead sawfly larvae among the nematode treatments. However there was a significant difference in the number of dead sawflies among the wheat varieties. Other results indicated that temperature impacted the effectiveness of the biologically based insecticides (spinosad and Beauveria bassiana) against the confused flour beetle and may be important when considering implementation of biological control programs.

4. Associated Knowledge Areas

- ☐ 211 - Insects, Mites, and Other Arthropods Affecting Plants
- ☑ 212 - Diseases and Nematodes Affecting Plants
- ☐ 213 - Weeds Affecting Plants
- ☐ 214 - Vertebrates, Mollusks, and Other Pests Affecting Plants
- ☑ 215 - Biological Control of Pests Affecting Plants
- ☑ 216 - Integrated Pest Management Systems
- ☐ 314 - Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards
- ☑ 601 - Economics of Agricultural Production and Farm Management
- ☐ 603 - Market Economics
- ☑ 711 - Ensure Food Products Free of Harmful Chemicals, Including Residues from
- ☐ 712 - Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☑ 903 - Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☑ Appropriations changes
- ☑ Public Policy changes
- ☑ Government Regulations
- ☐ Competing Public priorities
- ☐ Competing Programmatic Challenges
- ☑ Populations changes (immigration, new cultural groupings, etc.)
- ☐ Other

Brief Explanation

Global economic changes, unpredictable fertilizer prices, drought and fire, weeds and pests, expanding export markets, market volatility and cultural changes all contribute to a challenging path for producers to remain profitable and sustainable in the industry. Decreasing groundwater availability and drastic climate variations also present external factors to the program.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Stem rust, wheat stem sawfly, orange wheat blossom midge, late blight, Russian Olive, Fusarium head blight, cheatgrass, narrowleaf hawksbead, and wheat curl mites are only a small portion of current insects, diseases and invasive plants currently threatening the health and safety of Montana's agricultural industry and environmental sustainability.
The goals of this program include:

- Continue to provide pest and disease management information to agriculture and horticulture professionals and individuals
- Prioritize and coordinate pest management research, Extension and education programs
- Respond to the informational needs of the public and private sectors on a regional basis
- Create and develop new strategies to meet old and new pest and disease challenges

All goals are being well served through MAES/COA and Extension's daily efforts to improve integrated pest management strategies and share information with Montanans to improve profitability and sustainability of Montana agriculture and physical environment.

Key Items of Evaluation

- 38% of participants in 9 pesticide storage and security classes secured their pesticides before; 75% after
- 12% of participants in 4 presentations on pesticide performance and water quality tested the pH of their water before, even when using highly susceptible weak acid pesticides; 94% after
- 43% of participants at 3 presentations could calibrate their own pesticide sprayer before; after, 97%
- 2015 Schutter Diagnostic Lab comprehensive survey:
  - 99% of respondents rated SDL services highly or somewhat valuable
  - 88% received educational information in addition to their diagnosis recommendations
  - 93% said the SDL influenced their decisions, increased their knowledge and reduced pest spread
  - Estimated monetary value of SDL based on responses (n=489) was over $2 million
- Tests of trap efficiency:
  - Mean trap catches of wheat stem sawfly did not differ based on trap color
  - Colored traps caught more sawflies than either the bucket trap or delta trap
  - Unbaited bucket pitfall traps were the only traps to catch click beetles
- Entomopathogenic nematode strains mixed with water and Barricade were applied on wheat stubble of eight different hollow-stem varieties
  - No significant difference in dead sawfly larvae was observed among nematode treatments
  - A significant difference was found among wheat varieties
- Temperature impacted the effectiveness of spinosad and Beauveria bassiana against the confused flour beetle; and may be important when implementing biological control programs.
- Bacillus mycoides isolate J registration information was completed by CERTIS USA for the USA and Canada and full label acceptance is expected early 2016.
- Publications and presentations were made on applications for potato early blight, Sclerotinia white mold, sugarbeet Cercsopora leaf spot and wheat fusarium crown rot
- Pyrenophora semeniperda (PYSE) was tested as a biological control for downy brome
  - Initial data suggests PYSE had no effect on downy brome growth
  - More was learned about improving methods for revegetating invasive plant infested rangeland
- Results from revegetation studies will be used to create a decision-support tool to be used to help determine whether or not revegetation is necessary to achieve a desired plant community
- Nine Kochia accessions were included in a field study

- Emergence varied significantly with the highest emergence in North Dakota and Hays, KS accessions; and the least emergence in Manhattan, KS accessions
- Kochia accessions ranged from 150,000 to >500,000 seeds per plant in the non-competitive environment - demonstrating the need for location-specific biological data for Kochia management
- 3 Kochia populations from Toole County were confirmed with 2-way multiple resistance and 2 populations were confirmed with 3-way resistance - demonstrating further need for improved management
- Ecological and human-health risk assessments of emerging infectious diseases and insecticides used to control disease vectors revealed science-based risks, as well as uncertainty and variability associated with each risk type
- Toxicology research revealed the relationship between increasing ambient temperatures and mosquito mortality to pyrethroid insecticides

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Energy and Natural Resources

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	0%		10%	
104	Protect Soil from Harmful Effects of Natural Elements	5%		10%	
111	Conservation and Efficient Use of Water	0%		5%	
112	Watershed Protection and Management	5%		10%	
122	Management and Control of Forest and Range Fires	5%		0%	
123	Management and Sustainability of Forest Resources	5%		8%	
124	Urban Forestry	5%		3%	
131	Alternative Uses of Land	5%		5%	
132	Weather and Climate	0%		10%	
135	Aquatic and Terrestrial Wildlife	5%		3%	
136	Conservation of Biological Diversity	5%		10%	
141	Air Resource Protection and Management	0%		7%	
201	Plant Genome, Genetics, and Genetic Mechanisms	0%		5%	
402	Engineering Systems and Equipment	5%		0%	
605	Natural Resource and Environmental Economics	5%		14%	
903	Communication, Education, and Information Delivery	50%		0%	
	Total	100%		100%	

Add knowledge area

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890

Plan	4.5	0.0	22.9	0.0
Actual Paid	2.7	0.0	45.0	0.0
Actual Volunteer	1.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
51874	0	456759	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	1733529	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
87237	0	1734431	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

MSU researchers and Extension agents will work one on one and in groups with producers, landowners and consumers to identify and address individual and industry struggles and solutions. They will regularly answer specific questions through workshops, phone calls, email and personal consultations to address specific topics such as forest stewardship and water quality. MSU COA/MAES and Extension will partner with local and state associations and organizations that are concerned about natural resource issues. In particular, MSU Extension agents and COA/MAES specialists will engage with leaders concerned about natural resources in finding ways to provide meaningful resources and education/research while collaborating to solve problems and create strategies for future growth and development. Agents and specialists will offer classes, workshops, group discussions, demonstrations, and field tours/trials. Agents, specialists and volunteers will disseminate knowledge via community events and meetings. MSU Extension will also utilize PSA's, newsletters, MONTGuides, television, eXtension, listserves and other media.

2. Brief description of the target audience

- Private forest land owners and public land managers
- Farmers/Ranchers/Ag Producers
- Small acreage landowners
- Community leaders
- Professional loggers/foresters
- Environmental scientists
- Community leaders
- State economists
- Youth

3. How was eXtension used?

eXtension was used to research materials to prepare presentations. eXtension was also used to share information through fact sheets and answer Ask an Expert questions via the Rangeland Stewardship and Health Community of Practice (COP). Questions for Ask an Expert are also used to asssess clientele needs and help guide programming

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	5638	271565	3274	256111

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	12	54	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research citations

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	66

Output #2

Output Measure

- Number of meetings/workshops/clinics aimed at forest stewardship. Number of landowners and managers who create and implement forest stewardship plans.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	1160

Output #3

Output Measure

- Number of people attending Well Educated programs, who track water quality, regularly test their wells and receive information on how to help protect ground water resources. Number of people attending workshops and seminars to learn about watersheds and environmentally sustainable best practices.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	1208

Output #4

Output Measure

- Number of consumers, landowners and industry professionals utilizing resources created and/or consolidated by MSU Extension's E3A program. Number of people successfully completing E3A trainings.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #5

Output Measure

- Number of workshops and resources provided to assist landowners with leasing of mineral and water rights and other legal issues related to development. Number of collaborations with industry, agriculture and community leaders in eastern Montana.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increase number of private forest owners who create and implement forest stewardship plans that allow them to continue to provide economic, environmental and social benefits to Montanans. Increased number of people who gain knowledge about forestry management and sustainability issues and contribute to forest health.
2	Increased number of homeowners regularly testing wells and managing them for safe consumption and environmental soundness. Increased number of Montanans who utilize online Extension and other resources related to watershed protection, drinking water safety and other water quality topics.
3	Energy Efficiency and Alternatives: Increased number of consumers accessing and utilizing E3A resources and participating in training to improve efficiency, reduce environmental impacts and lower costs.
4	Natural Resource Development: Increased number of collaborations with partners in eastern Montana to explore benefits and challenges as a result of the Bakken Oil Field and related issues. Increase in the number of landowners who are educated and make sound decisions about water and mineral rights.
5	Conduct research that improves the health of Montana forests
6	Expand research in the genetic engineering of plant oils for industrial applications

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Increase number of private forest owners who create and implement forest stewardship plans that allow them to continue to provide economic, environmental and social benefits to Montanans. Increased number of people who gain knowledge about forestry management and sustainability issues and contribute to forest health.

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1160

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Montana has 25 million acres of forest, of which 4.4 million are owned by over 52,000 private individuals. Historically these family owned forests have supplied 30 percent of the annual Montana timber harvest and today they provide significantly more. These family forests also provide open space, clean water, wildlife habitat, and the recreational opportunities for which Montana is famous. In the recent years of severe wildfire, these lands, when well managed have provided an important wildfire control buffer between wildlands and the communities that surround them. The Montana Forest Stewardship Steering Committee advises MSU Extension Forestry in how to best meet the needs of these landowners.

What has been done
Extension Forestry provides forest landowner education programs ranging from core Forest Stewardship Planning Workshops to topic specific workshops like Windbreaks/Living Snowfences, Alternative Forest Management Practices, Wildfire Hazard Reduction, and Tree Pruning & Care. In addition, MSU Extension Forestry teaches the Project Learning Tree (PLT) environmental education program to teachers, other educators, parents and community leaders who work with youth from preschool through grade 12. The PLT's multi-disciplinary curriculum materials are aligned with state and national education standards. Extension Forestry also provides outreach through various tools including a calendar, news-releases, listservs, twitter, brochures and publications.

Results

In 2015, 54 educators completed the PLT training. Ninety-one percent used the curriculum to reach 2,689 students. Thirty-six Tree Farm re-certifications were completed representing 7,833 acres of Sustainable Forestry Initiative (SFI) certified forest. Forest Stewardship Class participants applied gained knowledge of their private lands. As an example, a family followed up after classes to secure a soil survey report for their land. The report provided critical information to refine management on their property, complete contracts and begin achieving long term resource goals including healthy forests and reducing invasive plants. In Lewistown, 20,500 tree seedlings were distributed to private landowners, 15 additional fruit trees and 15 berry bushes were planted in public orchards, 50 trees were planted in local parks and public areas and two groups of landowners created tree and shelterbelt plans for their neighborhoods.

4. Associated Knowledge Areas

- ☑ 102 - Soil, Plant, Water, Nutrient Relationships
- ☑ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☐ 111 - Conservation and Efficient Use of Water
- ☐ 112 - Watershed Protection and Management
- ☐ 122 - Management and Control of Forest and Range Fires
- ☑ 123 - Management and Sustainability of Forest Resources
- ☐ 124 - Urban Forestry
- ☑ 131 - Alternative Uses of Land
- ☑ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☐ 136 - Conservation of Biological Diversity
- ☐ 141 - Air Resource Protection and Management
- ☐ 201 - Plant Genome, Genetics, and Genetic Mechanisms
- ☐ 402 - Engineering Systems and Equipment
- ☐ 605 - Natural Resource and Environmental Economics
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Increased number of homeowners regularly testing wells and managing them for safe consumption and environmental soundness. Increased number of Montanans who utilize online Extension and other resources related to watershed protection, drinking water safety and other water quality topics.

2. Associated Institution Types

- ☑ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1208

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Montana has 60,000 miles of perennial streams which provide irrigation, drinking water and recreation. Approximately 45 percent of those streams are listed as impaired. Non-point sources of pollution cause most of the impairment in which everyone plays a role in. To improve management, the general public must understand that their actions have an impact and make decisions that mitigate damage. There is no government oversite of water quality for private drinking water wells so it is the homeowners? responsibility to test and understand their water quality.

What has been done
MSU Extension Water Quality (MSUEWQ) works with county partners and agencies to engage citizens in data collection to understand surface and groundwater issues. MSUEWQ works with eight watershed groups on surface water monitoring programs and more than 31 counties on groundwater testing through the Well Educated Program. The Well Educated program is a simple, cost effective way for well owners to test and understand their drinking water quality results. On the Flathead Reservation, 450 youth received riparian education and participated in hands-on riparian reconstruction experiments.

Results
The agent in Fergus County secured a $25,000 grant to do 20 baseline tests of groundwater. As a result, education was done related to improving water quality. Local fertilizer dealers reported a 25% increased demand for split application and environmentally friendly fertilizer sources. One landowner reported saving $15,000 on topsoil amendments based on what he learned from Extension. In Stillwater County, the agent secured a grant to continue testing livestock water sources. Water with up to 4,400 ppm of sulfur and other antagonists was identified ? and is a direct cause of reduced animal performance. The agent developed a computer program to add on to an existing ration balancing program that allows water analysis valued to be added to the feed to ensure that mineral formulations counteract antagonistic effects, saving producers further losses in revenue.

4. Associated Knowledge Areas

- ☑ 102 - Soil, Plant, Water, Nutrient Relationships

- ☑ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☑ 111 - Conservation and Efficient Use of Water
- ☑ 112 - Watershed Protection and Management
- ☑ 122 - Management and Control of Forest and Range Fires
- ☑ 123 - Management and Sustainability of Forest Resources
- ☑ 124 - Urban Forestry
- ☐ 131 - Alternative Uses of Land
- ☑ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☐ 136 - Conservation of Biological Diversity
- ☐ 141 - Air Resource Protection and Management
- ☐ 201 - Plant Genome, Genetics, and Genetic Mechanisms
- ☐ 402 - Engineering Systems and Equipment
- ☑ 605 - Natural Resource and Environmental Economics
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Energy Efficiency and Alternatives: Increased number of consumers accessing and utilizing E3A resources and participating in training to improve efficiency, reduce environmental impacts and lower costs.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	356

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Consumers are interested in reducing consumption, using more efficient energy sources and learning the latest technologies and solutions for being good stewards of limited resources.

Finding reliable, science-based information can be a challenge. The MSU Extension Weatherization Center offers resources and training for contractors, businesses and individuals. The Center works closely with Montana?s Human Resource Development Councils and Tribal associates to utilize safe, efficient, cutting edge techniques to address the health, safety and energy efficiency issues present in low-income housing.

What has been done
The Weatherization Center offered 31 classes for 338 participants. These included topics such as: Weatherization 101, Basic Furnace, Single Family Energy Auditor and EPA Lead Renovation, Repair and Paint Rule. MSU Extension manages Montana?s Ecostar Pollution Prevention Awards. During National Pollution Prevention week, businesses are recognized for creating more environmentally sustainable business models through pollution prevention strategies.

Results
According to the US Department of Energy, single family homes that were weatherized by the Weatherization Assistance Program (as offered through the Montana Weatherization Center) saved an average of $283 annually on energy costs. The national report found that benefits related to the Recovery Act of 2010 included approximately $14,000 in health and household related, non-energy benefits per single-family home. The report also found that for every dollar invested in weatherization, $4.50 was generated in energy and non-energy benefits. During 2015, Ecostar award winners conserved 8.4 million gallons of water, 3.5 billion British thermal units (BTUs) in heating, 6,725 pounds of hazardous waste, and reduced 1,300 metric tons of carbon dioxide emissions, while saving $450,000 through their pollution prevention work.

4. Associated Knowledge Areas

- ☐ 102 - Soil, Plant, Water, Nutrient Relationships
- ☐ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☐ 111 - Conservation and Efficient Use of Water
- ☐ 112 - Watershed Protection and Management
- ☐ 122 - Management and Control of Forest and Range Fires
- ☐ 123 - Management and Sustainability of Forest Resources
- ☐ 124 - Urban Forestry
- ☐ 131 - Alternative Uses of Land
- ☑ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☑ 136 - Conservation of Biological Diversity
- ☑ 141 - Air Resource Protection and Management
- ☐ 201 - Plant Genome, Genetics, and Genetic Mechanisms
- ☐ 402 - Engineering Systems and Equipment
- ☐ 605 - Natural Resource and Environmental Economics
- ☐ 903 - Communication, Education, and Information Delivery

Outcome #4

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Natural Resource Development: Increased number of collaborations with partners in eastern Montana to explore benefits and challenges as a result of the Bakken Oil Field and related issues. Increase in the number of landowners who are educated and make sound decisions about water and mineral rights.

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Little hard data exists about what happens in communities after peak drilling activity related to oil and gas development.

What has been done
A four state team is collaborating on a research project to study the impacts of oil and gas development in areas following a dramatic increase in activity during peak drilling.Pennsylvania State University, Cornell University, Montana State University and the University of Wyoming are conducting a survey to find out from the local level how businesses and landowners have benefited or been harmed in the long term. MSU Extension Community Development is assisting with the project which is made possible through a USDA NIFA grant.

Results
The Marcelles shale play in Pennsylvania, the Bakken oil field in North Dakota and Montana and the Powder River Basin in Wyoming have been selected for the study. The survey has been prepared and distribution plans are being determined. It is expected that this project will be completed in 2016.

4. Associated Knowledge Areas

☐ 102 - Soil, Plant, Water, Nutrient Relationships

- ☑ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☑ 111 - Conservation and Efficient Use of Water
- ☑ 112 - Watershed Protection and Management
- ☐ 122 - Management and Control of Forest and Range Fires
- ☐ 123 - Management and Sustainability of Forest Resources
- ☐ 124 - Urban Forestry
- ☑ 131 - Alternative Uses of Land
- ☐ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☐ 136 - Conservation of Biological Diversity
- ☑ 141 - Air Resource Protection and Management
- ☐ 201 - Plant Genome, Genetics, and Genetic Mechanisms
- ☐ 402 - Engineering Systems and Equipment
- ☐ 605 - Natural Resource and Environmental Economics
- ☑ 903 - Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Conduct research that improves the health of Montana forests

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◉ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Whitebark pines in Montana and the surrounding region are being decimated by white pine blister rust and mountain pine beetles. These forests are an important part of the Montana landscape and are critical as grizzly bear habitat, for production of pine nuts as part of the food chain for

squirrels, birds, and bears and are a keystone species in high elevation habitats. Whitebark pine forests occupy the top of watersheds and prevent soil erosion and slow snowmelt in the spring which extends stream flow longer into the summer. The species (Pinus albicaulis) is currently listed as endangered in Canada and is nominated for this status in the U.S. Substantial efforts to regenerate this endangered pine are ongoing by forest managers but survival rates are low.

What has been done
Pines cannot survive in nature without mycorrhizal fungi. These fungi provide the pines better access to nitrogen and some tolerance to drought. The goal of current research is to discover the native mycorrhizal fungi important to whitebark pine and develop protocols for their use in restoration, including development of techniques for adding the fungi (inoculation) to nursery seedlings with the goal of ultimately increasing seedling survival rates on restoration sites. Two new greenhouse experiments are examining if native ectomycorrhizal fungi can colonize soil from the Eureka burn, whether inoculated or naturally colonized; and if colonized seedlings contain more nitrogen.

Results
Ectomycorrhizal fungi was collected from Montana's whitebark forests. Researchers contributed to the database of mycorrhizal fungi found with whitebark pine, contributed voucher collections of these fungi to MONT herbarium, isolated living cultures of these mycorriihizal fungi and stored numerous spore slurries of native mycorrhizal fungi for use in future projects at MSU and elsewhere. Results continued to show that seedlings inoculated with native fungi, planted near shelter objects on burns, had the highest survival rates in the International Peace Park. This is significant because it is expensive to grow whitebark pine seedlings for restoration. Therefore, any technology that enhances seedling survival, will likely be cost effective and will result in the more efficient use of the resources already used in reforestation. Results were included in the U.S. Forest Service Range-Wide Strategy for whitebark pine. Initial greenhouse results show that native Suillus species specific to whitebark pine are able to colonize burn soil (at least in the greenhouse) and preliminarily show that they can increase total nitrogen in the greenhouse seedlings.

4. Associated Knowledge Areas

- ☑ 102 - Soil, Plant, Water, Nutrient Relationships
- ☐ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☑ 111 - Conservation and Efficient Use of Water
- ☑ 112 - Watershed Protection and Management
- ☑ 122 - Management and Control of Forest and Range Fires
- ☑ 123 - Management and Sustainability of Forest Resources
- ☐ 124 - Urban Forestry
- ☐ 131 - Alternative Uses of Land
- ☑ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☑ 136 - Conservation of Biological Diversity
- ☐ 141 - Air Resource Protection and Management
- ☐ 201 - Plant Genome, Genetics, and Genetic Mechanisms
- ☐ 402 - Engineering Systems and Equipment

- ☐ 605 - Natural Resource and Environmental Economics
- ☐ 903 - Communication, Education, and Information Delivery

Outcome #6

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Expand research in the genetic engineering of plant oils for industrial applications

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is a growing need for renewable sources of environmentally friendly biofuels and biomaterials such as lubricants to replace or supplement products currently manufactured from petroleum. Basic research will advance our understanding of biochemical and genetic mechanisms that govern the diversity of fatty acids in plant seed oils, and guide effective engineering of oilseed crops for improved oil quality. Camelina (Camelina sativa) is an emerging crop in the Great Plains, and has potential for becoming a dedicated industrial oilseed for the production of bio-based fuels and lubricants.

What has been done
During this reporting period, microRNAs from Camelina sativa were sequenced and analyzed. MicroRNA has been recognized as a key regulator in plant development and metabolism. Further objectives for the current research are to engineer the fatty acid composition of camelina seeds for the production of vegetable oils with improved lubricant functionalities; to produce novel hydroxy fatty acids in camelina oils; and to understand the acly fluxes during triacylglycerol biosynthesis in seeds.

Results
Results (the first to be reported in C. sativa) indicated that miRNAs are differentially expressed in different tissues and at different developmental stages of seeds. The hypothesis is that some miRNAs may target lipid metabolism genes and regulate fatty acid modification and/or oil

accumulation in seed. The bioinformatics results have been published. Next experiments will test the roles of selected microRNAs in Camelina seeds on modification of fatty acid composition and oil accumulation. For hydroxyl fatty acid production in seed, a phospholipase C from castor (Ricinus communis) was found to increase HFA accumulation in Camelina seed when co-expressed with the castor fatty acid hydroxylase (FAH12). This was reported at the Gordon Research Conference of Plant Lipids.

4. Associated Knowledge Areas

- ☐ 102 - Soil, Plant, Water, Nutrient Relationships
- ☐ 104 - Protect Soil from Harmful Effects of Natural Elements
- ☐ 111 - Conservation and Efficient Use of Water
- ☐ 112 - Watershed Protection and Management
- ☐ 122 - Management and Control of Forest and Range Fires
- ☐ 123 - Management and Sustainability of Forest Resources
- ☐ 124 - Urban Forestry
- ☐ 131 - Alternative Uses of Land
- ☐ 132 - Weather and Climate
- ☐ 135 - Aquatic and Terrestrial Wildlife
- ☐ 136 - Conservation of Biological Diversity
- ☐ 141 - Air Resource Protection and Management
- ☑ 201 - Plant Genome, Genetics, and Genetic Mechanisms
- ☐ 402 - Engineering Systems and Equipment
- ☐ 605 - Natural Resource and Environmental Economics
- ☐ 903 - Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☑ Appropriations changes
- ☑ Public Policy changes
- ☑ Government Regulations
- ☑ Competing Public priorities
- ☑ Competing Programmatic Challenges
- ☐ Populations changes (immigration, new cultural groupings, etc.)
- ☐ Other

Brief Explanation

Natural resources are greatly impacted by factors beyond human control, leaving those who depend on these resources challenged to develop flexible management plans that ensure resiliency, viability and profitability.

Accelerated growth in eastern Montana, followed by a sharp exodus of people, presents many challenges and opportunities which are and will continue to be affected by national and state government policies, funding for energy development issues, taxation policies and more. These rapid changes result in a great need for Extension to provide science-based resources and facilitate community and leadership development to mitigate political and social impacts.
Other external factors include the retirement of the housing specialist and director of the Montana Weatherization Center. This position continues to be unfilled.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

This program was successful in meeting goals including:

- Increased awareness and knowledge of landowners, service providers and managers on core and emerging natural resource topics.
- Increased awareness by volunteers about their impact on local watersheds.
- Increased knowledge of homeowners who test and manage their wells.

MSU Extension moved to an entirely new planning and reporting system during 2014. The system, along with extensive training, is improving planning, evaluation and reporting methods, though the transition has been a challenge and continued through 2015.

Key Items of Evaluation

- 54 educators completed the Project Learning Tree training.
- Ninety-one percent used the curriculum to reach 2,689 students.
- Thirty-six Tree Farm re-certifications were completed representing 7,833 acres of Sustainable Forestry Initiative (SFI) certified forest.
- In Lewistown, 20,500 tree seedlings were distributed to private landowners, 15 additional fruit trees and 15 berry bushes were planted in public orchards, 50 trees were planted in local parks and public areas and two groups of landowners created tree and shelterbelt plans for their neighborhoods.
- Five new publications with topics ranging from tree pruning to biomass markets were created and disbursed.
- 28 page Montana Family Forest News magazine was mailed to 6,000+.
- Produced and aired 240 Forestry Minutes for radio with listenership of 25,000.
- The agent in Fergus County secured a $25,000 grant to do 20 baseline tests of groundwater.
    - As a result, education was done related to improving water quality.
    - Local fertilizer dealers reported a 25% increased demand for split application and environmentally friendly fertilizer sources.
- One landowner reported saving $15,000 on topsoil amendments based on what he learned from Extension.
- In Stillwater County, the agent secured a grant to continue testing livestock water sources. Water with up to 4,400 ppm of sulfur and other antagonists was identified - and is a direct cause of reduced animal performance. The agent developed a computer program to add on to an existing ration balancing program that allows water analysis valued to be added to the feed to ensure that mineral formulations counteract antagonistic effects, saving producers further losses in revenue.

- The Montana Weatherization Center participates in the Weatherization Assistance Program which reportedly saved residential customers an average of $283 annually on energy costs. The USDA's national report also found that benefits related to the Recovery Act of 2010 included approximately $14,000 in health and household related, non-energy benefits per single-family home. The report also found that for every dollar invested in weatherization, $4.50 was generated in energy and non-energy benefits.
- During 2015, Ecostar award winners conserved 8.4 million gallons of water, 3.5 billion British thermal units (BTUs) in heating, 6,725 pounds of hazardous waste, and reduced 1,300 metric tons of carbon dioxide emissions, while saving $450,000 through their pollution prevention work.
- The Marcelles shale play in Pennsylvania, the Bakken oil field in North Dakota and Montana and the Powder River Basin in Wyoming have been selected for a study of the impact of oil and gas development after peak drilling. The survey has been prepared and distribution plans are being determined. It is expected that this project will be completed in 2016.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Youth and Family Development

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
307	Animal Management Systems	5%		0%	
602	Business Management, Finance, and Taxation	5%		0%	
801	Individual and Family Resource Management	25%		0%	
802	Human Development and Family Well-Being	25%		0%	
806	Youth Development	35%		0%	
903	Communication, Education, and Information Delivery	5%		0%	
	Total	100%		0%	

Add knowledge area

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	8.0	0.0	0.0	0.0
Actual Paid	11.4	0.0	0.0	0.0
Actual Volunteer	46.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
395229	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
122860	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Conduct workshops and clinics that provide active learning in subject matter related to projects
- Conduct meetings that focus on facilitation and leadership skills
- Develop curriculum and supporting teaching tools for volunteers to use
- Provide training for youth and adult volunteers
- Partner with youth serving groups on state and local levels
- Provide/develop web based education and information access
- Facilitate small support groups for caregivers
- Develop printed and online resources

2. Brief description of the target audience

- Youth aged 5-19
- Parents of youth involved in 4-H
- Adult and youth volunteer leaders
- Professionals involved with youth development
- School administrators and teachers
- Military families
- Rural Montana families, landowners and business owners
- Caregivers
- Healthcare providers and services
- Reservation populations

3. How was eXtension used?

eXtension was used for:

- Connecting with resources and specialists from other states
- Youth leadership programming
- Peer-reviewed and innovative planning, program development and evaluation tools
- Leadership training
- Techniques for working with youth and adult volunteers
- 4-H curriculum
- Implementation of citizenship programs

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	17057	154533	33072	61362

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	22	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Youth competency development: Number of 4-H programs and activities to provide youth with training and support to foster the development of skills and abilities in citizenship, science and healthy living.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	36118

Output #2

Output Measure

- Youth life skill development: Number of 4-H Youth programs which provides activities and projects to help youth build specific life skills.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	18242

Output #3

Output Measure

- Leadership/Volunteer Development: Number of classes, seminars and resources for youth and adults who volunteer in youth programs to help them become better, more effective leaders.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	3518

Output #4

Output Measure

- Military Family Partnerships: Number of positive interactions with military families through partnerships with other organizations and schools to access resources and support opportunities.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #5

Output Measure

- Parenting/Caregiving: Number of classes and support groups for parents and caregivers.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	2045

Output #6

Output Measure

- Personal Finances: Number of classes, training and resources that provide critical information related to personal finances and the Affordable Care Act (ACA).

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	3401

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Youth competency development: Increased number of youth participating in 4-H projects and activities and demonstrating increased knowledge and ability in specific competency areas including but not limited to science, healthy living and citizenship.
2	Youth life skill development: Increased number of youth participating in 4-H activities and demonstrating increased knowledge and ability in specific life skill areas including but not limited to teamwork, communication skills and public speaking.
3	Leadership/Volunteer Development: Increased number of youth and adults who have received leadership training and demonstrate increased knowledge and ability as a result of the training.
4	Military Family Partnerships: Increased interaction with military families resulting in increased capacity of families to access resources and support.
5	Parenting/Caregiving: Increased number of parents and caregivers who access support and resources and increased knowledge and ability of participants as a result of those efforts.
6	Personal Finances: Increased number of participants in classes and training and increased knowledge and aptitude of those participants based on pre and post survey results. Number of ACA inquiries, referrals, resources developed and shared, workshops and enrollments.

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Youth competency development: Increased number of youth participating in 4-H projects and activities and demonstrating increased knowledge and ability in specific competency areas including but not limited to science, healthy living and citizenship.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2112

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Department of Commerce estimates that Science, Technology, Engineering and Math (STEM) occupations will grow 1.7 times faster than non-STEM jobs between 2008 and 2018. To meet these workforce needs, the United States will need approximately 1 million more STEM professionals than are projected to graduate over the next decade. Research has shown that 4-H members develop an increased interest in science three times higher than non-4-Hers.

What has been done
Montana youth participated in 36,118 projects related to science, technology, engineering and math (STEM). These projects included: robotics, bioscience, livestock, foods and nutrition, environmental education, plant sciences and engineering. NILE Ag in the Classroom reached 1300 4th graders from Montana?s largest community who learned about crops, livestock and more. Youth in livestock projects learned about animal selection, training, care, record keeping, showmanship and marketing. The Natural Resources and STEM Discovery Day Camp at MSU hosted 70 4-H kids who toured campus. They learned how they can use what they are learning in 4-H when they go to college and about possible STEM careers.

Results
The Montana 4-H Science Team created a Google docs file and provided STEM curriculum, including newly created supplements, in a central location for agents to utilize. They created a grant process and awarded grants to 4-H clubs and committees to use in STEM related projects and events. One hundred percent of youth who received Reality Store financial training spent less than they earned and reported they increased knowledge in how to make smart financial

decisions, including how to use a savings account. One hundred percent of youth enrolled in shooting sports learned safe and responsible use of firearms and archery equipment. The International Livestock Judges Training program had 112 participants who collectively judged 615 county shows, 57 state shows and 28 regional shows. One 19 year-old stated, "I started livestock judging when I was 8 years old and competed at national competitions and had much success. Because of this, I have had the opportunity to attend College and be on the Casper College Livestock Judging Team." Another: "Being a part of the BioScience Montana project helped me get into college and definitely landed me a job at Carroll College in the Labs."

4. Associated Knowledge Areas

- ☐ 307 - Animal Management Systems
- ☐ 602 - Business Management, Finance, and Taxation
- ☐ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 806 - Youth Development
- ☐ 903 - Communication, Education, and Information Delivery

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Youth life skill development: Increased number of youth participating in 4-H activities and demonstrating increased knowledge and ability in specific life skill areas including but not limited to teamwork, communication skills and public speaking.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	18242

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Instability due to family situations and other challenges leads young people to be at risk. 4-H can serve as the catalyst between at-risk behavior and positive behavior. The Positive Development of Youth: Comprehensive Findings from the 4-H Study of Positive Youth Development is a longitudinal study that began in 2002 and was repeated annually for eight years, surveying more

than 7,000 adolescents from diverse backgrounds across 42 states. The study found that 4-Hers are about: four times more likely to make contributions to their communities (grades 7-12), two times more likely to make healthier choices (7th grade); and two times more likely to participate in STEM programs outside of school (grades 10-12).

What has been done
Montana 4-H creates environments for positive youth development through experiential education, learning-by-doing projects, club meetings, community service projects, after-school programs, school enrichment, camps, conferences, international programs and exchanges and other events and activities. During 2015, 18,242 youth participated in 4-H activities. Of these 8,585 were members of 4-H clubs. Over 12% were Native American, compared to 6.6% of the overall population. 4-H directly contributes to the development of youth through programs in communication and public speaking, goal setting, professional etiquette, leadership and decision-making.

Results
Girls indicated a measurable improvement in feelings of self-worth from their 4-H experience as measured by pre- and post- tests. Youth practiced formal interviews and were given direct feedback on how to improve. Several participants reported this education gave them confidence and a competitive edge that resulted in employment. Club officers learned parliamentary procedure, how to balance a check book and create and follow a budget, how to take meeting minutes and how to manage committees. Youth learned how to make S.M.A.R.T. goals; and each made at least one. Youth learned to increase tolerance for diversity and expanded understanding of other cultures. Ninety-seven percent of kids at camp (n=38) said they learned new skills and 100% said they felt included and safe. Another camp (n=138) found 80% learned to respect other opinions and make friends and 90% tried a new activity they would do again after camp.

4. Associated Knowledge Areas

- ☐ 307 - Animal Management Systems
- ☐ 602 - Business Management, Finance, and Taxation
- ☐ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 806 - Youth Development
- ☐ 903 - Communication, Education, and Information Delivery

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Leadership/Volunteer Development: Increased number of youth and adults who have received leadership training and demonstrate increased knowledge and ability as a result of the training.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	3518

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Critical to the 4-H experience are trained, caring adults who are matched with youth to create partnerships that increase the competence, connection, confidence, compassion and character necessary for youth to become contributing members of society.

What has been done
MSU Extension actively recruits and trains caring adults to mentor youth. During 2015, 3518 youth and adults served as volunteers. Counties and regions provide training through local programming, 4-H Congress and Leadership Institute, camp counselor training and one-on-one interactions.

Results
In 2015, Montana reported 3518 volunteers who contributed 94,217 hours of time to youth and family development. This is an economic value of $1.9 million. A leadership survey was given to youth at the beginning of programming and after (n=400). Responses from pre- to post- changed as follows: "I am a leader" 56% to 89%; "I have a plan to reach my goals" 56% said to 78%; and "I show respect for others" 67% to 89%. Overall, 89% said they saw themselves as effective leaders who were becoming vital members of the community. On another survey (n=126), 30% increased their time management skills. Another (n=240): 49% said it's definitely true that "I am motivated to accomplish more because of 4-H leadership training" and 47% said it was probably true. Because of being camp counselors, teens reported, "I have become way more involved in my community", "I am better at decision making and talking to people", "I am now confident to share my ideas and opinions freely in a group decision", and "I have gone from being someone who would rather follow, to someone who is willing to take on responsibility and get out in front of people."

4. Associated Knowledge Areas

- ☐ 307 - Animal Management Systems
- ☐ 602 - Business Management, Finance, and Taxation
- ☐ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 806 - Youth Development

☐ 903 - Communication, Education, and Information Delivery

Outcome #4

1. Outcome Measures

☑ Not Reporting on this Outcome Measure

Military Family Partnerships: Increased interaction with military families resulting in increased capacity of families to access resources and support.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

☐ 307 - Animal Management Systems
☐ 602 - Business Management, Finance, and Taxation
☐ 801 - Individual and Family Resource Management
☑ 802 - Human Development and Family Well-Being
☑ 806 - Youth Development
☐ 903 - Communication, Education, and Information Delivery

Outcome #5

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Parenting/Caregiving: Increased number of parents and caregivers who access support and resources and increased knowledge and ability of participants as a result of those efforts.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2045

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
By 2025, it is expected that more than a quarter of Montana's population will be over 65 years of age, ranking between third and fifth in the nation. Along with extended life expectancy comes a variety of chronic illnesses. Research studies find high rates of depression and anxiety among caregivers and increased vulnerability to health problems. According to AARP's 2014 "Across the States Report", Montana ranked 49/50 for support for caregivers. In the 2012 report Montana had 131,000 family caregivers providing services valued at $1.39 million. The same study showed that 88 percent of these caregivers never get a break. It is not uncommon for the stress of caregiving to cause serious illness for the caregiver. In addition, more than 6,600 grandparents in Montana are responsible for the primary care of their grandchildren.

What has been done
Powerful Tools for Caregivers (PTC) is an educational program that provides family caregivers with skills and confidence to better care for themselves while caring for someone with a chronic illness. The Extension PTC class trains instructors to conduct six weekly 90-minute classes in communities across Montana to empower caregivers. Ten series were held this year with 89% retention. The Montana Grandparents Raising Grandchildren (GRG) Project focuses on providing education, support and resources for grandparent-headed families. The project provides support group facilitator training and coordinates a network of 31 education/support groups across the state, including on the seven Indian Reservations.

Results
Eight new PTC leaders were trained. The Montana Lifespan Respite Coalition adopted PTC as the main educational program for caregivers and has given funding for nine scholarships for

Coalition members to become trained. They also developed a Public Service Announcement promoting the program. Because grandparents often care for their grandchildren informally, the state saves more than $200,000/day in foster care payments ($30/day x 6600 kids). Valuable partnerships with professionals and organizations have increased the number of facilitators and resources for families in this situation. More than 175 grandparents actively participate in support groups, 550 receive newsletters three times annually. The Montana GRG project has an active Facebook page, listserv and website to remain in close contact with participants. These services helped Montana rank in the top 10 states for providing services and support for grandfamilies. At least 11 families created wills through GRG's partnership with other Extension services.

4. Associated Knowledge Areas

- ☐ 307 - Animal Management Systems
- ☐ 602 - Business Management, Finance, and Taxation
- ☐ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 806 - Youth Development
- ☐ 903 - Communication, Education, and Information Delivery

Outcome #6

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Personal Finances: Increased number of participants in classes and training and increased knowledge and aptitude of those participants based on pre and post survey results. Number of ACA inquiries, referrals, resources developed and shared, workshops and enrollments.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	3401

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Montanans are interested in the wise use and handling of their financial resources, especially as it relates to passing property of all types from one generation to another. Statistics reveal that 70 percent of Montanans die without a will. Being informed on estate planning is the only way

individuals/families can be sure their final wishes are realized. The state legislature continues to change intestate succession (dying without a will law) and contract laws that impact beneficiaries of real and personal property. In addition, Congress has made changes in the federal estate and gift tax laws that are termed permanent from 2013 forward. Education is needed to provide Montana families with information about the impact of state and federal laws on their situations.

What has been done

During 2015, the family economics specialist reached 1378 people in 48 Montana communities with a variety of estate planning programs. Of participants, nearly 60 percent did not have an estate plan and 92 percent were incorrect when asked about property distribution in a specific situation. The Solid Finances program reached 254 people in live sessions and 1769 via webinar recordings. Solid Finance topics included: Common Law Marriage and Estate Planning; Financial Fads, Diets and Short Term Efforts; Home Buying; Using Financial Aps and Websites; Why Buy Insurance; Financial Records Organization: Preparing for Emergencies and Disasters and Senior Financial Protection: Diminished Capacity, the Aging Population and Financial Decisions.

Results

Before estate planning workshops 79% had not placed Pay-on-Death (POD) or Transfer-on-Death (TOD) beneficiaries on their assets; after, 93% indicated they would do so. Ninety-four percent said they planned to talk with family about estate planning and 91% would review their beneficiary designations; 15 percent intended to write a will, 30 percent to review their will and 38 percent to see an attorney about executing a will. Change from before Solid Finances to after in rating of 4 or 5 (1=know nothing and 5 = know a lot): I understand how financial apps work and can help me track my finances 29% to 82%; I understand how insurance fits into a financial plan 35% to 76%; I know steps to increase my retirement income 30% to 92%; I understand how trusts could be part of an estate plan 18% to 64%. A follow-up survey found that 30% had utilized tools to avoid probate on their estate; 20% had written separate listings of tangible personal property for distribution after death; and 15% had started using a financial app or website to help manage finances.

4. Associated Knowledge Areas

- ☐ 307 - Animal Management Systems
- ☑ 602 - Business Management, Finance, and Taxation
- ☑ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 806 - Youth Development
- ☐ 903 - Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☑ Appropriations changes
- ☑ Public Policy changes
- ☑ Government Regulations
- ☐ Competing Public priorities
- ☑ Competing Programmatic Challenges
- ☑ Populations changes (immigration, new cultural groupings, etc.)
- ☐ Other

Brief Explanation

Due to reduced staff in the Montana 4-H office, and the loss of grant funding for a military family coordinator, partnerships weren't monitored separately. There was one camp in Lewis and Clark County and there were Military Clubs in Yellowstone, Lewis and Clark and Cascade counties. These had 84 total members.
MSU Extension is continuing to work on creating better statewide evaluation and assessment processes to collect stronger data on a broader spectrum.
When writing the 2015 Plan of Work, we created output measures that weren't quantitative, tried to measure multiple things, or asked to measure things that we haven't been able to track. We will correct these statements in the 2017 Plan of Work. In the meantime we attempted to include the outputs within the outcomes to demonstrate successful completion of the intended outputs.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

MSU Extension recognizes that families come in a variety of configurations and offer resources and training to assist them in navigating all the various stages and changes that occur across generations. Montanans desire resources to support youth and that help them to become better caregivers for the elderly and disabled friends and family. They seek resources for successfully parenting grandchildren and for managing their own aging process, including planning for transfer of wealth and managing personal finances. MSU Extension is fully engaged in meeting all these needs in every county and on every reservation for all Montanans across generations.

Key Items of Evaluation

- Eight new Powerful Toots for Caregivers (PTC) leaders were trained
- The Montana Lifespan Respite Coalition adopted PTC as the main educational program for caregivers and it has been nominated for the Western Extension Directors Award of Excellence.
- Montana earned a top 10 rank for states providing the best services and support for Grandfamilies.

- Financial education programs reached 3401 participants
- Before estate planning workshops 79% had not placed Pay-on-Death (POD) or Transfer-on-Death (TOD) beneficiaries on their assets; after, 93% indicated they would do so.
- Ninety-four percent said they planned to talk with family about estate planning and 91% would review their beneficiary designations; 15 percent intended to write a will, 30 percent to review their will and 38 percent to see an attorney about executing a will.
- Change from before Solid Finances to after in rating of 4 or 5 (1=know nothing and 5 = know a lot):
  - I understand how financial apps work and can help me track my finances 29% to 82%
  - I understand how insurance fits into a financial plan 35% to 76%
  - I know steps to increase my retirement income 30% to 92%
  - I understand how trusts could be part of an estate plan 18% to 64%.
  - A follow-up survey found that
    - 30% had utilized tools to avoid probate on their estate
    - 20% had written separate listings of tangible personal property for distribution after death
    - 15% had started using a financial app or website to help manage finances
- Montana 4-H had 3518 volunteers who contributed 94,217 hours at a value of $1.9 million
- A leadership survey was given to youth at the beginning of programming and after (n=400). Responses from pre- to post- changed as follows: "I am a leader" 56% to 89%; "I have a plan to reach my goals" 56% said to 78%; and "I show respect for others" 67% to 89%. Overall, 89% said they saw themselves as effective leaders who were becoming vital members of the community.
- On a different 4-H leadership survey (n=126), 30% increased their time management skills.
- An additional 4-H leadership survey (n=240): 49% said it's definitely true that "I am motivated to accomplish more because of 4-H leadership training" and 47% said it was probably true.
- 12% of Montana 4-H participants were Native American compared to 6.6% of the population.
- The Montana 4-H Science team created new curriculum supplements and a central website with a Google docs file for agents to easily find curriculum and created a grant process for clubs to access funds for STEM projects and events.

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Healthy Living, Nutrition and Food Safety

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
701	Nutrient Composition of Food	0%		25%	
702	Requirements and Function of Nutrients and Other Food Components	10%		25%	
703	Nutrition Education and Behavior	10%		0%	
704	Nutrition and Hunger in the Population	20%		0%	
721	Insects and Other Pests Affecting Humans	0%		25%	
722	Zoonotic Diseases and Parasites Affecting Humans	0%		25%	
724	Healthy Lifestyle	20%		0%	
801	Individual and Family Resource Management	10%		0%	
802	Human Development and Family Well-Being	20%		0%	
805	Community Institutions, Health, and Social Services	10%		0%	
	Total	100%		100%	

Add knowledge area

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	4.0	0.0	6.3	0.0
Actual Paid	4.1	0.0	0.0	0.0
Actual Volunteer	2.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
116061	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
131420	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Conduct train the trainer workshops
- Conduct workshops, seminars, meetings
- Facilitate meetings, discussion groups, focus groups
- Develop local and state partnerships
- Develop MontGuides (fact sheets), publications, website materials, video based materials
- Conduct web based, interactive training/education opportunities

2. Brief description of the target audience

- Low income adults
- Low income youth
- Adults that are Supplemental Food Assistance (SFA) eligible
- Youth from SFA eligible households
- Teachers in the Montana School System
- Middle to older aged women, especially those living in rural areas
- Parents and youth living in rural areas
- Working people
- Elderly and shut-in people
- Food service managers and staff
- Tribal members

3. How was eXtension used?

eXtension was used for newsletters, fact sheets, general resources and evaluation tools and reports.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	11703	78158	9583	11215

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	1	14	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Healthy Lifestyles: Classes and resources, printed and online, are readily available to Montanans to increase knowledge related to physical activities and the need for proactive medical testing.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #2

Output Measure

- Nutrition: Classes, publications and online resources are utilized to provide current information regarding nutrition, food resource management tools and other dietary needs directly to Montanans.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #3

Output Measure

- EFNEP/SNAP-Ed: The NEP curriculum is utilized to teach qualifying adults and youth, a series of lessons related to nutrition and food resource management.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	8068

Output #4

Output Measure

- Food Safety: County Agents are trained to offer food safety education classes and ServSafe training to local sanitarians, school and public food service personnel, volunteers and others.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	1437

Output #5

Output Measure

- Food preservation: Training and updates for County Extension Agents equip them to conduct educational programs, test equipment and answer questions.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Healthy Lifestyles: Increased participation in healthy lifestyle programming and health monitoring that leads to healthy lifestyle choices.
2	Nutrition: Increased participation in nutrition classes, training and use of online and printed resources leading to measureable changes in nutrition habits.
3	EFNEP/SNAP-Ed: Increased participation by eligible citizens, leading to increased knowledge related to improved nutrition and food resource management.
4	Food Safety: Increased participation in food safety classes, trainings and increased knowledge, utilization and certifications earned by participants.
5	Food preservation: Increased participation in food preservation classes and increased knowledge and utilization of concepts learned by participants.
6	Research: Increase understanding of the metabolic parameters influencing development and progression of fatty liver disease
7	Research: Better understand Staphylococcus aureus colonization in humans and livestock

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Healthy Lifestyles: Increased participation in healthy lifestyle programming and health monitoring that leads to healthy lifestyle choices.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	976

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Chronic diseases are Montana's leading cause of death, illness and disability and account for approximately 70 percent of healthcare costs. In Montana, heart disease is the leading cause of death and along with other diseases including diabetes, stroke, osteoporosis and hypertension, significantly impact quality of life. Research shows that healthy food choices, physical activity and early detection of symptoms can prevent or delay these diseases, saving millions in health care costs and preserving quality of life. Utilizing its network across the state and trusting relationships of agents in local communities, MSU Extension works with the Montana Department of Health and Human Services and other agencies to provide educational programming that fits the particular needs of each county.

What has been done
At least eight counties have active Strong Women Programs which provide structured exercise and nutrition information twice weekly for 10-12 weeks. Many counties currently partner with others in their communities to offer some type of health fair. Extension is a partner in the Montana Arthritis Program (MAP) and numerous counties implement the Arthritis Foundation Exercise Program (AFEP) for their residents. Rural Extension faculty proactively partner to offer healthy living education activities to meet needs that span all generations. Twelve medically underserved rural Montana communities are participating in Strong Heart, Healthy Communities (SHHC), a National Institute of Health research project in cooperation with Cornell, Tufts and MSU Extension.

Results

One hundred percent of participants who responded after completing Strong Women or AFEP programs reported reduced pain and stiffness, increased range of motion and balance and improved sleep. Qualitative improvements include: being able to open a jar and/or button a shirt, having strength to climb stairs, ability to lift bag into overhead compartment on a plane, more comfort in living alone, improved dexa-scan readings that doctor attributed partially to classes and weight loss. Participants in the Stillwater Healthy Living Program reported saving an average of $530/year through gym savings and discounted or free health screenings. In addition they reduced arthritis pain by 75%, increased mobility by 50% and lowered blood pressure by 10 pts. Sixty percent said they learned at least one healthy lifestyle change that they were implementing regularly. Cumulative, quantitative data is not available at this time though efforts to improve data collection are under way.

4. Associated Knowledge Areas

- ☐ 701 - Nutrient Composition of Food
- ☐ 702 - Requirements and Function of Nutrients and Other Food Components
- ☑ 703 - Nutrition Education and Behavior
- ☑ 704 - Nutrition and Hunger in the Population
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☐ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☑ 724 - Healthy Lifestyle
- ☑ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 805 - Community Institutions, Health, and Social Services

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Nutrition: Increased participation in nutrition classes, training and use of online and printed resources leading to measureable changes in nutrition habits.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1075

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is a need for horticulture and gardening programing in Montana. According to the Montana Food Bank, thirty of Montana?s 56 counties have areas considered food deserts. During the growing season, calls to a county Extension office are over 50 percent horticulture- or IPM-related and in some counties the percent is upwards of 90 percent. Master Gardener curriculum educates the general public in horticulture, yard and garden maintenance and IPM. The Master Gardener program requires participants to volunteer as a condition of becoming certified. Increasing the ability for citizens to access or grow their own sustainable, local foods is a priority for MAES, COA and Extension.

What has been done
The Master Gardener program has three levels of classes. Level 1 includes basic and intermediate curriculum, Level 2 includes a large emphasis on integrated pest management and Level 3 is a three-day intensive training held on the MSU campus in Bozeman. In addition, many counties offer horticulture classes and projects to meet the direct needs of their communities. Agents respond to regular drop-ins, phone calls and emails and many offer weekly columns and/or set up booths at Farmer's markets to answer questions. Many communities, including reservations, have thriving community gardens as a result of the Master Gardener program; and thousands of pounds of fresh produce are donated annually to Food Banks.

Results
MSU Extension created a series of 22 Food Fact Sheets that describe how to grow, preserve, clean, prep and prepare fruits and vegetables commonly grown in Montana. The MSU Extension Master Gardener program certified 243 (144 Level 1, 81 Level 2 and 18 Level 3) new Master Gardeners in 2015. These, as well as 816 already active Master Gardeners reported 15,254 hours of volunteer time at a value of $352,000. Thirty prisoners at the State Women's Prison became certified and produced 4,920 pounds of produce which was used in the prison kitchen. In Dawson County, the Eastern Plains Event Center commercial kitchen provided opportunities for local food growers to use the facilities and be educated on how to move their food entrepreneur ideas from conception to market. In Deer Lodge County gardeners rented 65 plots which produced an average of 72 pounds of vegetables at a net value of about $500 each. A Greenhouse Symposium helped 87 citizens learn to build a greenhouse and 86% reported they were able to increase production 18%; while reducing chemical use by 8% as a result.

4. Associated Knowledge Areas

- ☐ 701 - Nutrient Composition of Food
- ☑ 702 - Requirements and Function of Nutrients and Other Food Components
- ☑ 703 - Nutrition Education and Behavior
- ☑ 704 - Nutrition and Hunger in the Population
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☐ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☑ 724 - Healthy Lifestyle
- ☑ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 805 - Community Institutions, Health, and Social Services

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

EFNEP/SNAP-Ed: Increased participation by eligible citizens, leading to increased knowledge related to improved nutrition and food resource management.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	8068

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Food insecurity and hunger is prevalent in Montana. One in nine Montanans face hunger/food insecurity; 29% of Montana children and 61% of adults are overweight or obese (74% of American Indian Montana adults); 20% of Montana adults eat less than 1 serving of vegetables a day; and 77% of Montana adults do not get enough aerobic and muscle-strengthening exercises to meet guidelines. Accessing affordable, healthy foods is a challenge and can result in obesity and health issues. Nutrition education helps Montanans learn how to stretch their food dollars while meeting USDA dietary guidelines.

What has been done
SNAP Education (SNAP-Ed) programs provide hands-on nutrition and physical activities designed to reduce food insecurity and help families lead a healthier lifestyle. Adult nutrition series were offered, along with classes for youth in Title One schools. Each series included six classes for adults and 1st, 3rd and 5th grade children in 14 counties and six reservations. The Expanded Food and Nutrition Education Program (EFNEP) served the very poor within Montana's three largest cities: Billings, Missoula and Great Falls. Nutrition educators coordinate with other community resources to provide holistic support.

Results
All participants reported some level of improved behaviors related to diet quality, food resource management, physical activity and or food safety. SNAP-Ed post-series youth surveys found that 78% of children improved their ability to choose foods according to MyPlate and 27% increased physical activity. EFNEP post series adult survey showed: 89% improved at least one food resource management practice (plan meals, compare prices, use grocery list); 78% were

physically active "almost always" or "most of the time" by the end of the class; and 94% improved at least one nutrition practice that was taught in the class. At one school, EFNEP students were able to cook with zucchini, beets and pumpkin they helped grow in the school garden. A teen mom who graduated from the Eating Smart Being Active EFNEP series indicated she understood how to read labels and was more confident in making healthier food choices for herself and her child.

4. Associated Knowledge Areas

- ☐ 701 - Nutrient Composition of Food
- ☑ 702 - Requirements and Function of Nutrients and Other Food Components
- ☑ 703 - Nutrition Education and Behavior
- ☑ 704 - Nutrition and Hunger in the Population
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☐ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☑ 724 - Healthy Lifestyle
- ☑ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 805 - Community Institutions, Health, and Social Services

Outcome #4

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Food Safety: Increased participation in food safety classes, trainings and increased knowledge, utilization and certifications earned by participants.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1437

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Each year in America there are over 48 million documented cases of food-borne illness. The

financial cost of food-borne illness is tremendous, including lost wages, health care and investigative costs. Basic food safety training on controlling time and temperature when handling food, and ensuring proper cleaning and sanitizing reduces the incidence of food-borne illness. Many food service groups, including school systems, Head Start and food banks, now require food safety training. In January, 2015, the Montana Rule for Retail Food Establishments went into effect requiring additional training for retail employees and volunteers serving food.

What has been done
ServSafe is the educational program of the National Restaurant Association and is widely recognized throughout the United States. Extension professionals from at least 15 counties or reservations are certified trainers of this program. They provided dozens of 2-hour/Level 1, 4-hour/Level 2 and 8-hour/Level 3 sessions to 1437 individuals. Depending on the level, participants learn: controlling time and temperature; ensuring proper personal hygiene; preventing cross-contamination; proper cleaning and sanitizing; the impact of safety on an operation; the flow of food through an operation and managing a food-safe operation.

Results
Establishments who had people in the Level 3 (Food Safety Manager) course reported introducing or changing practices within the establishment's standard operating procedures based on the skills and concepts taught in the course. In Rosebud-Treasure counties a savings of $8,000 was reported for local establishments because training was offered locally. Statewide nearly 100 percent passed the Level 1 and Level 2 certifications while over 90 percent passed Level 3 certification. At least nine participants who were released from the Nexus Treatment Center found work in food service in part because they were certified. A partnership was formed among MSU Flathead Reservation Extension, the Confederated Salish and Kootenai Tribes sanitarian, and both Lake County and Lincoln County Environmental Health offices to provide the owners and operators of area food establishments with food safety education.

4. Associated Knowledge Areas

- ☐ 701 - Nutrient Composition of Food
- ☐ 702 - Requirements and Function of Nutrients and Other Food Components
- ☑ 703 - Nutrition Education and Behavior
- ☑ 704 - Nutrition and Hunger in the Population
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☐ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☑ 724 - Healthy Lifestyle
- ☐ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 805 - Community Institutions, Health, and Social Services

Outcome #5

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Food preservation: Increased participation in food preservation classes and increased knowledge and utilization of concepts learned by participants.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Montana has an abundance of nutritious, seasonal, wild and homegrown foods. Sustainable food trends, the slow economy, and presence of food deserts across Montana have all increased interest in home food preservation as an important and popular activity. Recent national surveys reveal that a high percentage of home food processors are using practices that put them at high risk for food-borne illness and economic loss due to food spoilage. MSU Extension has long been recognized as a credible source for science-based recommendations for home food preservation. These trends bring renewed effort to provide enhanced programming opportunities.

What has been done
Extension utilizes many strategies for educating the public about safe food preservation. Every office responds to drop-in visitors, phone calls and emails asking individual questions. MontGuides, fact sheets and other resources are distributed during county fairs, farmers' markets, community events and during trainings. Classes covering topics such as canning; water bath canning; meat preserving and canning; pickling, freezing; drying and the science of food-borne illnesses and how to prevent them, are offered in communities all across the state. Extension faculty share information through newspaper articles, blogs, listservs, newsletters, radio spots, and social media and pressure-gauge testing at local hardware and grocery stores.

Results
Participants of Extension training learned that poorly canned or preserved food can be life threatening and is relatively easy to prevent. They learned where to find trusted resources. They reported learning how to avoid food waste and save money, how to increase the usable harvest yield, how to improve food quality and nutrition (special dietary restriction, less preservatives or added chemicals, reduced sodium, etc.) and to prevent food borne illness/death. County offices regularly tested pressure gauges for pressure canners to insure they were safe for use. At least six individuals became Master Food Preservers allowing them to teach food preservation classes.

4. Associated Knowledge Areas

- ☐ 701 - Nutrient Composition of Food
- ☑ 702 - Requirements and Function of Nutrients and Other Food Components
- ☑ 703 - Nutrition Education and Behavior
- ☑ 704 - Nutrition and Hunger in the Population
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☐ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☑ 724 - Healthy Lifestyle
- ☑ 801 - Individual and Family Resource Management
- ☑ 802 - Human Development and Family Well-Being
- ☑ 805 - Community Institutions, Health, and Social Services

Outcome #6

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Research: Increase understanding of the metabolic parameters influencing development and progression of fatty liver disease

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Tens-of-millions of Americans have fatty liver disease (FLD) and an estimated eight million of these will progress to liver cirrhosis. Most cases of FLD are caused by excessive consumption of calories and/or alcohol, and therefore, nearly all attempts to treat this disease are behavioral. Unfortunately, the prevalence of FLD indicates that behavioral approaches are not adequately effective. Research to understand the genetic, metabolic, and systemic physiological processes that underlie FLD is needed.

What has been done
This research project seeks to better understand the metabolic pathways leading to FLD such that one might design dietary, food-source, or food supplement protocols that might eliminate or

abrogate the physical manifestation of FLD even in people who continue to partake in high-risk behaviors. The goal is to see whether simple and palatable shifts in the nation's food supply or in the USDA's nutritional recommendations might be effective at reducing national rates of FLD. Tests are underway to measure the impact of disrupting TrxR1 on liver oxidative stress, how changes in hepatic TrxR1 activity affect hepatic energy metabolism, and whether dietary selenium content can affect development of FLD.

Results
Ongoing studies are measuring the impact of disrupting TrxR1 and correlating changes in hepatic lipid-versus-glycogen accumulation with accumulation of oxidative damage to macromolecules. Ongoing studies are investigating how changes in hepatic TrxR1 activity, nucleotide metabolism, and sulfur-amino acid metabolism in cells are correlated. Dietary studies have not yet been initiated. Ongoing studies are characterizing the liver protein thiolome, protein S-nitrosothiolome, and protein persulfidome in normal and TR/GR-null livers. Dietary supplementation studies are under-way with large amounts of data currently being generated. Five related peer-reviewed journal articles were published in 2015, two in 2014.

4. Associated Knowledge Areas

- ☑ 701 - Nutrient Composition of Food
- ☑ 702 - Requirements and Function of Nutrients and Other Food Components
- ☑ 703 - Nutrition Education and Behavior
- ☐ 704 - Nutrition and Hunger in the Population
- ☐ 721 - Insects and Other Pests Affecting Humans
- ☑ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☐ 724 - Healthy Lifestyle
- ☐ 801 - Individual and Family Resource Management
- ☐ 802 - Human Development and Family Well-Being
- ☐ 805 - Community Institutions, Health, and Social Services

Outcome #7

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Research: Better understand Staphylococcus aureus colonization in humans and livestock

2. Associated Institution Types

- ☐ 1862 Extension
- ☑ 1862 Research

3a. Outcome Type:

- ◉ Change in Knowledge Outcome Measure
- ◯ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Staphylococcus aureus (S. aureus) is a leading cause of human infections worldwide. In the U.S., an estimated 12 million outpatient visits occur annually because of S. aureus skin and soft-tissue infections, and invasive S. aureaus disease was responsible for nearly 19,000 deaths in 2015. In recent years, there has been an increase in the incidence of community-associated methicillin-resistant S. aureus (CA-MRSA) infections in healthy individuals and the most prominent strains have been associated with severe pathology including sepsis, necrotizing pneumonia, and necrotizing fasciitis. Paradoxically, healthy adults are commonly colonized with S. aureus that is asymptomatic.

What has been done
There is strong evidence that nasal colonization is a risk factor for subsequent infections. The long term goal of current research is to address the role of nasal carriage in S. aureus pathogenesis. The overall objective is to use comparative genetic and phenotypic analyses to investigate unique adaptations of virulent strains to the nasal niche by comparing strains originally isolated from active infections to strains of the same type but isolated from normal nasal microbiota. Methicillin-resistant S. aureus are the leading cause of infections presenting to emergency departments and account for 59% of skin and soft-tissue infections. They are also the major cause of mastitis in dairy cattle and can cause devastating infections in equines. This project will increase understanding of the role S. aureus colonization plays in health.

Results
Researchers have collected a unique set of S. aureus isolates from nasal microbiota from an at-risk Native American population. They are also focusing on the incidence of carriage in horses and in cows with mastitis (investigating both colonization and the presence of S. aureus in infected milk, or from the infected tissue of horses). This will allow them to characterize human and animal nasal and infection isolates and determine quantitative differences in virulence between nasal isolates and isolates from active infection. This will help determine if colonization is a risk factor for disease. So far, using S. aureus strains isolated from mastitic cattle, researchers generated new data related to bovine immunity. The chemokine CCL28 has been shown to play a key role in secreting cells to the mammary gland. CCL28 was found to be highly correlated with the lactation cycle. These results suggest a potential role for CCL28 in the prevention/resolution of bovine mastitis. One peer reviewed journal article was published and another has been accepted.

4. Associated Knowledge Areas

- ☑ 701 - Nutrient Composition of Food
- ☑ 702 - Requirements and Function of Nutrients and Other Food Components
- ☐ 703 - Nutrition Education and Behavior
- ☐ 704 - Nutrition and Hunger in the Population

- ☑ 721 - Insects and Other Pests Affecting Humans
- ☑ 722 - Zoonotic Diseases and Parasites Affecting Humans
- ☐ 724 - Healthy Lifestyle
- ☐ 801 - Individual and Family Resource Management
- ☐ 802 - Human Development and Family Well-Being
- ☐ 805 - Community Institutions, Health, and Social Services

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☑ Appropriations changes
- ☑ Public Policy changes
- ☑ Government Regulations
- ☑ Competing Public priorities
- ☑ Competing Programmatic Challenges
- ☐ Populations changes (immigration, new cultural groupings, etc.)
- ☐ Other

Brief Explanation

MSU Extension utilizes train-the-trainer methods to reach more people with limited resources. Data from classes taught by Extension volunteers is not always easy to access, though is clearly an impact of Extension work. MSU Extension is continuing to work with faculty on creating effective evaluation tools and improving methods for gathering qualitative outcomes.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation tools most utilized were pre- and post-test surveys. MSU Extension continues to work on improving the skills of faculty related to conducting needs assessments, improving strategic planning, developing stronger evaluation tools, and maximizing data collection.
When writing the 2015 Plan of Work, we created output measures that weren't quantitative, tried to measure multiple things, or asked to measure things that we haven't been able to track. We will correct these statements in the 2017 Plan of Work. In the meantime we attempted to include the outputs within the outcomes to demonstrate successful completion of the intended outputs.

Key Items of Evaluation

- 100% of participants who responded reported that Strong Women or Arthritis Foundation Exercise programs helped reduce pain and stiffness, increased range of motion

and balance and improved sleep

- Stillwater Healthy Living Program participants reported saving an average of $530/year
  - reduced arthritis pain by 75%
  - Increased mobility by 50%
  - Lowered blood pressure by 10 pts
- Extension created 22 Food Fact Sheets that describe how to grow, preserve, clean and prepare fruits and vegetables commonly grown in Montana.
- Extension Master Gardener program certified 243 new Master Gardeners in 2015. These, as well as 816 already active Master Gardeners, reported 15,254 hours of volunteer time valued at $352,000.
- 30 prisoners at the State Women's Prison became certified and produced 4,920 pounds of produce which was used in the prison kitchen
- Deer Lodge County gardeners rented 65 plots which produced an average of 72 pounds of vegetables at a net value of about $500 each.
- A Greenhouse Symposium helped 87 citizens learn to build a greenhouse
  - 86% reported they were able to increase production 18%; while reducing chemical use by 8%.
- SNAP-Ed youth surveys found: 78% of children improved their ability to choose foods according to MyPlate and 27% increased physical activity.
- EFNEP adult surveys showed: 89% improved at least one food resource management practice (plan meals, compare prices, use grocery list) and 94% improved at least one nutrition practice.
- At one school, EFNEP students learned to cook with vegetables they helped grow in the school garden.
- Establishments with Level 3 (Food Safety Manager) graduates reported changing standard operating procedures based on the skills and concepts learned in the course.
- Rosebud-Treasure counties reported saving $8,000 for local establishments because ServSafe training was offered locally.
- In Statewide ServSafe classes nearly 100% passed Level 1 and Level 2 certifications while over 90% passed Level 3 certification.
- 9 participants released from the Nexus Treatment Center found work in food service in part because they were ServSafe certified.
- MSU Flathead Reservation Extension, the Confederated Salish and Kootenai Tribes sanitarian, and Lake County and Lincoln County Environmental Health offices formed a partnership to provide area food establishments with food safety education.
- Six individuals became Master Food Preservers allowing them to teach food preservation classes.
- Ongoing studies are measuring the impact of TrxR1 on fatty liver disease. Dietary supplementation studies are under way with large amounts of data currently being generated. Five peer-reviewed journal articles were published in 2015
- Using S. aureus strains isolated from mastitic cattle, researchers generated new data related to bovine immunity. The chemokine CCL28 has been shown to play a key role in secreting cells to the mammary gland. CCL28 was found to be highly correlated with the lactation cycle. These results suggest a potential role for CCL28 in the prevention/resolution of bovine mastitis. One peer reviewed journal article was published and another has been accepted.

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Community Development

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
608	Community Resource Planning and Development	60%		0%	
723	Hazards to Human Health and Safety	10%		0%	
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	20%		0%	
805	Community Institutions, Health, and Social Services	10%		0%	
	Total	100%		0%	

Add knowledge area

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	3.5	0.0	0.0	0.0
Actual Paid	3.7	0.0	0.0	0.0
Actual Volunteer	1.2	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
99095	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
78823	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• Community meetings will be held to determine community values, attitudes and vision on which to develop strategies and action plans.
• Partnering with local economic development entities, agencies, businesses/industry and organizations to implement goals and plans of action.
• Planning for potential disasters that may occur in a community, e.g., EDEN.
• Training opportunities available for people serving on boards, councils and committees in both the public and private sectors.
• Culturally sensitive meetings with tribal leaders focused on community development.

2. Brief description of the target audience

• Business and Community Leaders
• Local Development Entities
• Chamber of Commerce Members
• Tourism Leadership - local/state
• County and City Government
• County DES, Law Enforcement Emergency Response Coordinators
• Current community leadership/potential community leaders
• Landowners
• Adults/Youth serving on Boards
• Elected officials
• Tribal members

3. How was eXtension used?

eXtension was used to access Extension communities of practice (such as the Livestock and Poultry Environmental Learning Center), the Extension Disaster Education Network and other resources and planning and evaluation tools.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	9550	122762	841	3300

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2015
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	8	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Community Resource Development: Community Foundations, endowments or similar collaborations receive training and assistance focused on keeping wealth within the community to be used toward common strategic initiatives.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	1813

Output #2

Output Measure

- Governance and Citizen Leadership: Training offered through Extension Community Development and the MSU Extension Local Government Center to elected and public officials and volunteers.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	6100

Output #3

Output Measure

- Emergency/Disaster Planning and Management: Workshops, presentations, and other assistance offered in support of Emergency/Disaster Planning and Management to create disaster response plans.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	557

Output #4

Output Measure

- Community Development with Tribal Populations: Number of collaborations with tribes focused on community development issues. Workshops, presentations and assistance offered to tribal populations in forming collaborations focused on community development issues.

☑ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Community Resource Development: Increased participation of community members toward supporting established community priorities with a resulting increase in the number of Community Foundations and endowments.
2	Citizen Leadership and Good Governance: Increased number of people serving on boards, councils and/or committees who are prepared for the responsibilities/authorities of the entity.
3	Emergency/Disaster Planning and Management: Increased number of communities creating and updating clear disaster mitigation plans with effective and efficient leadership by Extension personnel during emergencies.
4	Community Development with Tribal Populations: Increased number of collaborations with tribes to address specific community development priorities.

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Community Resource Development: Increased participation of community members toward supporting established community priorities with a resulting increase in the number of Community Foundations and endowments.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	1813

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the Center for Rural Entrepreneurship, Montanans will be transferring $123 billion dollars of wealth between generations in the next 40 years (2010). The Rural Community Development Initiative (RCDI) is a 3 year collaboration among MSU Extension, the Montana Community Foundation and Anaconda Local Development Corporation; and funded by USDA Rural Development. If 5% of $123 billion was put in an endowment, Montana communities would have access to $307 million each year.

What has been done
MSU Extension facilitates Transfer of Wealth, Strategic Planning and Grant Writing training for foundations and their partners. In addition to increasing the effectiveness of Community Foundations in raising funds, the programs increase local leadership abilities, improve relationships and trust and engage community members in critical conversations about their desired future. The RCDI is working to strengthen Montana's 75 community foundations and build the capacity of all communities to retain wealth that is vital to their sustainability.

Results
Stillwater County secured a $25,000 grant to begin planning for a new County Library. The County has committed an additional $20,000 and another grant is pending for $20,000.
Liberty County raised more than $4,000 toward a $25,000 permanent endowed community foundation within the Montana Community Foundation. They allocated $1,000 to three local non-profits for community vitality projects.
Northern Rosebud County Community Foundation gave out approximately $15,000 in grants to

community improvement projects. The total endowment increased to over $367,000. This includes the first planned gift which came as a result of written communication from the foundation to the donors.

4. Associated Knowledge Areas

- ☑ 608 - Community Resource Planning and Development
- ☐ 723 - Hazards to Human Health and Safety
- ☑ 803 - Sociological and Technological Change Affecting Individuals, Families, and
- ☑ 805 - Community Institutions, Health, and Social Services

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Citizen Leadership and Good Governance: Increased number of people serving on boards, councils and/or committees who are prepared for the responsibilities/authorities of the entity.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	6100

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Montana county and city officials are responsible for more than $1 billion in public funds and more than 11,000 employees. Many of these public servants have little or no training for those roles and responsibilities, human resources, public meeting laws or budgeting and financing. The MSU Extension Local Government Center (LGC) provides the only training and technical assistance of its kind for Montana city and county elected officials and employees. The Montana Constitution requires a Voter Review Process every 10 years for all local governments: the LGC hosted training for review groups in 2015.

What has been done
The MSU Extension LGC offers more than 100 affordable professional development workshops each year. Over 90 percent of Montana's clerks of district court complete a 40-hour (4-year)

certification program and over 70 percent of municipal clerks, treasurers and finance officers participate in a 120 hour (3-year) certification program. In total, more than 6,100 officials and board members attended one or more LGC workshops in the last fiscal year.

Results
The LGC received $180,000 in permanent base funding from the Montana Legislature. This allowed for the hire of an associate director (1.0 FTE), associate specialist (.25FTE), program assistant (.75 FTE) and a graduate student (.5 FTE). A new MSU LGC Advisory Board was formed and held its first meeting in December 2015. The Municipal Institute included 97 clerks and treasurers and 65 elected officials. Overall the program was rated 4.52/5.00. The County Elected Officials Training had 45 attendees and was rated 4.57/5.00. The publication, Montana Counties on the Move was revised. This publication originated in 1974 and was first updated in 1990. It is a full history of county government in Montana.

4. Associated Knowledge Areas

- ☑ 608 - Community Resource Planning and Development
- ☐ 723 - Hazards to Human Health and Safety
- ☑ 803 - Sociological and Technological Change Affecting Individuals, Families, and
- ☑ 805 - Community Institutions, Health, and Social Services

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Emergency/Disaster Planning and Management: Increased number of communities creating and updating clear disaster mitigation plans with effective and efficient leadership by Extension personnel during emergencies.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	557

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
During 2015, the United States of America endured the worst bird flu outbreak in its history. The

avian flu H5N2 virus claimed the lives of roughly 48 million birds in 15 states, including Montana, though mostly in Iowa and Minnesota. The economic loss to the industry, including feed suppliers, trucking companies, processing plants and other related businesses exceeded $1 billion. The key to recovery of the industry included the safe disposal of carcasses and the proper disinfecting of facilities prior to repopulating flocks.

What has been done
The MSU Extension livestock environment associate specialist is an animal mortality expert and was called by the U.S. Department of Agriculture to serve in the epicenter of the outbreak. He was part of a comprehensive disaster team in Willmar, Minnesota and served as a subject matter expert by advising and educating on proper mortality compost management and inspected facilities to ensure compliance.

Results
The USDA's national compost team developed a suite of resources for future outbreaks regarding mortality management. Recommendations and testimonials are continuing to be reviewed to determine specific best management practices for future outbreaks. Much has been learned and precautions have been taken to lessen the risk of future impacts. The Extension specialist provided a presentation for eXtension on October 16, 2015 that continues to be available for future management.

4. Associated Knowledge Areas

- ☑ 608 - Community Resource Planning and Development
- ☑ 723 - Hazards to Human Health and Safety
- ☐ 803 - Sociological and Technological Change Affecting Individuals, Families, and
- ☑ 805 - Community Institutions, Health, and Social Services

Outcome #4

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Community Development with Tribal Populations: Increased number of collaborations with tribes to address specific community development priorities.

2. Associated Institution Types

- ☑ 1862 Extension
- ☐ 1862 Research

3a. Outcome Type:

- ◯ Change in Knowledge Outcome Measure
- ◉ Change in Action Outcome Measure
- ◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual

2015 591

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Fort Belknap Reservation lies in a food desert, meaning fruits and vegetables are limited within a 10-mile radius. This affects the health, economic development and poverty level of reservation residents. The Fort Belknap Food Sustainability Project (FBFSP) will teach and mentor residents in producing their own homegrown and organic food. The White Clay and Nakado tribes historically lived off the land and preserved their food. The FBFSP will enrich the people through cultural practices including food preparation, gathering, gardening, preservation, drying and selling/trading.

What has been done
A variety of classes was offered through the year, including: meat cutting and drying (participants learned how to cut the meat off a deer carcass and dry/jerky drying techniques); introduction to canning and canning safety; pickling cucumbers, peaches and beets, making apple filling; apple and plum jam; making choke cherry syrup; and gardening and nutrition. During MidWinter Fair, schools families, elders and communities came together for a jerky making workshop and a contest for canned foods - 523 participants. Extension worked with the Lodge Pole Red River Community Council to plan the Lodge Pole Trading Post. Facebook was used to share information on food preservation and gardening.

Results
The Lodge Pole Community Garden was actively worked through weekly visits by community members and yielded approximately 1000 pounds of vegetables to community members. Volunteers harvested, preserved, processed, distributed and saved seeds from the produce and are already planning for next year. Classes in Agency, Lodgepole, Hays and Dodson produced over 370 of jars of preserved foods including pickles, salsa, meat, vegetables and fruits. A new Orchard at Lodgepole was sponsored by the Wasay Wakpa Community Council and included 72 fruit trees. Additional partnerships include the Partnership with Native Americans, an organization that provided funding for a complete high tunnel, and community members who provided sweat equity and irrigation services. The Office of Public Instruction funded two small school-based gardens at Hays Lodgepole School and at Lodgepole Elementary. MSU Extension partnered with Aaniiih Nakoda College to start a walking club. Staff is allowed 90 minutes of paid work time to participate.

4. Associated Knowledge Areas

- ☐ 608 - Community Resource Planning and Development
- ☐ 723 - Hazards to Human Health and Safety
- ☑ 803 - Sociological and Technological Change Affecting Individuals, Families, and
- ☑ 805 - Community Institutions, Health, and Social Services

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☐ Appropriations changes
- ☑ Public Policy changes
- ☑ Government Regulations
- ☑ Competing Public priorities
- ☑ Competing Programmatic Challenges
- ☑ Populations changes (immigration, new cultural groupings, etc.)
- ☐ Other

Brief Explanation

Outcomes are affected by significant natural or other emergency/disasters. As federal funding becomes less secure, local communities will be required to set priorities and Extension will have a role in identifying and developing resources (financial and human) to be most effective.
When writing the 2015-2020 Plan of Work we created Output Measures that weren't measurable - hence not reporting on them in this annual report. We will correct this in the 2017-2022 Plan of Work.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

MSU Extension Community Development programs have effectively impacted each community in Montana. From expanding Community Foundation opportunities, to creating sustainable food systems in food deserts, to planning and preparing for emergencies to educating community officials and board members, MSU Extension is actively working in communities throughout Montana to improve their vitality and the quality of life of residents.
When writing the 2015 Plan of Work, we created output measures that weren't quantitative, tried to measure multiple things, or asked to measure things that we haven't been able to track. We will correct these statements in the 2017 Plan of Work. In the meantime we attempted to include the outputs within the outcomes to demonstrate successful completion of the intended outputs.

Key Items of Evaluation

• Stillwater County secured a $25,000 grant to begin planning for a new County Library. The County has committed an additional $20,000 and another grant is pending for $20,000.
• Liberty County raised more than $4,000 toward a $25,000 permanent endowed community foundation within the Montana Community Foundation. They allocated $1,000 to three local non-profits for community vitality projects.
• Northern Rosebud County community Foundation gave out approximately $15,000 in

grants to community improvement projects. The total endowment increased to over $367,000.

- The LGC received $180,000 in permanent base funding from the Montana Legislature. This allowed for the hire of an associate director (1.0 FTE), associate specialist (.25FTE), program assistant (.75 FTE) and a graduate student (.5 FTE).
- A new MSU LGC Advisory Board was formed and held its first meeting in December 2015.
- The Municipal Institute included 97 clerks and treasurers and 65 elected officials. Overall the program was rated 4.52/5.00.
- The County Elected Officials Training had 45 attendees and was rated 4.57/5.00.
- The publication, Montana Counties on the Move was revised. This publication originated in 1974 and was first updated in 1990. It is a full history of county government in Montana.
- The USDA's national compost team, including an MSU Extension specialist, developed a suite of resources regarding mortality management for future outbreaks of H5N2.
- Developed an eXtension presentation: Mortality Management Options During an Avian Influenza Outbreak.
- The Fort Belknap Sustainable Foods program continued to grow:
  - The Lodge Pole Community Garden yielded approximately 1000 pounds of vegetables for community members.
  - Classes in Agency, Lodgepole, Hays and Dodson produced 370+ of jars of preserved foods including pickles, salsa, meat, vegetables and fruits.
  - A new Orchard at Lodgepole was sponsored by the Wasay Wakpa Community Council and included 72 fruit trees.
  - The Partnership with Native Americans provided $2500 funding for a complete high tunnel.
  - Received $2500 Harvesting Healthy Communities grant to start a Hays Community Garden.
  - The Office of Public Instruction funded two small school-based gardens at Hays Lodgepole School and at Lodgepole Elementary.
  - MSU Extension partnered with Aaniiih Nakoda College to start a walking club. Staff is allowed 90 minutes of paid work time weekly to participate.
- The Northern Cheyenne Community Gardening Program
  - provided 300 pounds of Certified Seed Potatoes
  - 8 new gardens were established by community members
  - 1000s of packets of seeds were distributed
  - 120 kids helped plan and maintain a new Boys & Girls Club garden
- Fort Peck Tribes gave the Fort Peck Extension office use of acreage
  - Contributed over 1000 pounds of potatoes and 500 pounds of other vegetables to the Tribal Elderly Program and the local food bank.

V(A). Planned Program (Summary)

Program # 9

1. Name of the Planned Program

Housing and Built Environments

☐ Reporting on this Program

Reason for not reporting

Our Housing specialist retired and hasn't been replaced. Many of the programs continue, though their impacts fit well in other planned program areas so they have been moved accordingly.

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	2.0	0.0	2.9	0.0
Actual Paid	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual Volunteer	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 Matching	1890 Matching	1862 Matching	1890 Matching
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 All Other	1890 All Other	1862 All Other	1890 All Other
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Produce MontGuides on current energy topics.

- Conduct community meetings on energy topics
- Partner with agencies, local and tribal governments, organizations and industry to achieve more widespread impacts.
- Conduct meetings and seminars on methods for evaluating alternative energy opportunities for residential consumers and contractors.
- Conduct workshops on home energy for the building/remodeling industry.

2. Brief description of the target audience

- Residential energy consumers
- People interested in becoming involved with creating alternative energy opportunities
- Small businesses by SBA definition
- Building Industry
- Montana Department of Environmental Quality
- Montana AARP
- Human Resource Development Councils

3. How was eXtension used?

{No Data Entered}

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2015

Actual: {No Data Entered}

Patents listed

{No Data Entered}

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	{No Data Entered}	{No Data Entered}	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Training residential consumers: Classes will be offered online and in person for consumers interested in reducing energy costs and consumption.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #2

Output Measure

- Training Professional Contractors: Training and professional certification will be offered for those in the construction and weatherization industries; giving professionals the latest science-based information and technologies available.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #3

Output Measure

- Housing and Environmental Quality: Training opportunities and up-to-date resources related to housing safety will be available for consumers and contractors.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Training Residential Consumers: Consumers will utilize resources, increase knowledge and demonstrate positive change related to weatherization making homes more energy efficient.
2	Training Professional Contractors: Building and weatherization professionals will gain the knowledge and use the tools or materials needed to remodel or construct safe, energy efficient housing.
3	Housing and Environmental Quality: Increased number of homes cleared of mold and lead-based paint issues resulting in more residents living in safe conditions.

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Training Residential Consumers: Consumers will utilize resources, increase knowledge and demonstrate positive change related to weatherization making homes more energy efficient.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Training Professional Contractors: Building and weatherization professionals will gain the knowledge and use the tools or materials needed to remodel or construct safe, energy efficient housing.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Housing and Environmental Quality: Increased number of homes cleared of mold and lead-based paint issues resulting in more residents living in safe conditions.

2. Associated Institution Types

☑ 1862 Extension
☐ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◉ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☑ Appropriations changes
- ☑ Public Policy changes
- ☑ Government Regulations
- ☑ Competing Public priorities
- ☑ Competing Programmatic Challenges
- ☑ Populations changes (immigration, new cultural groupings, etc.)
- ☐ Other

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

V(A). Planned Program (Summary)

Program # 10

1. Name of the Planned Program

Horticulture

☐ Reporting on this Program

Reason for not reporting

Content and research highlights within this planned program has been absorbed into the new Plant Sciences planned program area. For reporting in Horticulture, see: Plant Sciences. (Beginning with the 2016 annual report, the planned program name will become Plant and Soil Sciences. This better aligns with Montana State University's strategic research goals in Hatch funding and structuring.)

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	1.5	0.0	40.5	0.0
Actual Paid	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
Actual Volunteer	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}	{NO DATA ENTERED}

V(D). Planned Program (Activity)

1. Brief description of the Activity

1.) Conduct horticulture science research projects
2.) Share and disseminate research findings to the public
2.) Conduct workshops and public seminars for Master Gardener Program
3.) Provide training in horticulture management
4.) Provide support in disease and pest diagnosis
5.) Partner with specialists, community members and agents to engage and inform the public
6.) Facilitate research findings with program leadership
7.) Assess public interest in horticulture programs through agent input
8.) Work with state media to disseminate knowledge and programs
9.) Foster best practices in horticulture training and programs
10.) Develop pest management programs

2. Brief description of the target audience

Community and professional gardeners
Horticulture research scientists
Plant pathology scientists
Extension agents
Farm and Ranch community
Agribusiness community
Local food producers

3. How was eXtension used?

{No Data Entered}

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2015
Actual: {No Data Entered}

Patents listed
{No Data Entered}

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	{No Data Entered}	{No Data Entered}	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of community members enrolled in Master Gardener Program

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #2

Output Measure

- Number of Extension agents assisting community members with plant pest diagnostics

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #3

Output Measure

- Number of plant pest and disease diagnostics performed for the public

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #4

Output Measure

- Number of public programs, trainings and seminars relating to plant pathology and horticulture

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

Output #5

Output Measure

- Number of published, peer reviewed materials.

☐ Not reporting on this Output for this Annual Report

Year	Actual
2015	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of community members completing and becoming certified in Master Gardener Program
2	Number of extension agents assisting community members with plant pest diagnostics
3	Number of plant pest and disease diagnostics performed for the public
4	Number of public programs, trainings and seminars related to plant pathology and horticulture
5	Number of published, peer reviewed materials

Add Cross-cutting Outcome/Impact Statement or Unintended or Previously Unknown Outcome Measure

Outcome #1

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Number of community members completing and becoming certified in Master Gardener Program

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◯ Change in Knowledge Outcome Measure
◉ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

Outcome #2

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Number of extension agents assisting community members with plant pest diagnostics

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

Outcome #3

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Number of plant pest and disease diagnostics performed for the public

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

Outcome #4

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Number of public programs, trainings and seminars related to plant pathology and horticulture

2. Associated Institution Types

☑ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done

{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

Outcome #5

1. Outcome Measures

☐ Not Reporting on this Outcome Measure

Number of published, peer reviewed materials

2. Associated Institution Types

☐ 1862 Extension
☑ 1862 Research

3a. Outcome Type:

◉ Change in Knowledge Outcome Measure
◯ Change in Action Outcome Measure
◯ Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

V(H). Planned Program (External Factors)

External factors which affected outcomes

- ☑ Natural Disasters (drought, weather extremes, etc.)
- ☑ Economy
- ☐ Appropriations changes
- ☐ Public Policy changes
- ☐ Government Regulations
- ☑ Competing Public priorities
- ☐ Competing Programmatic Challenges
- ☑ Populations changes (immigration, new cultural groupings, etc.)
- ☐ Other

Brief Explanation

{No Data Entered}

V(I). Planned Program (Evaluation Studies)

Evaluation Results

{No Data Entered}

Key Items of Evaluation

{No Data Entered}

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
8068	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
0	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.